ARCHITECTURAL BUILDING CONSTRUCTION

VOLUME ONE

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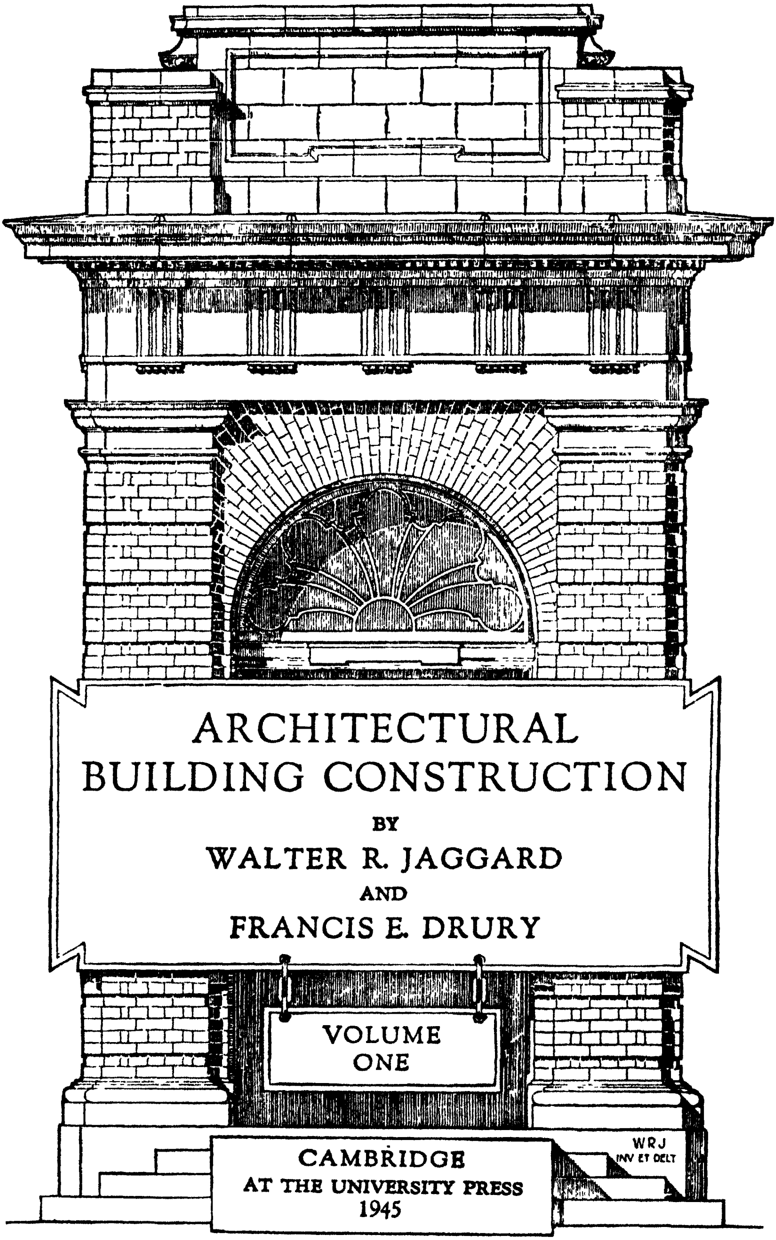

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BY

WALTER R. JAGGARD

AND

FRANCIS E. DRURY

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AT THE UNIVERSITY PRESS
1945

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A TEXT BOOK FOR THE ARCHITECTURAL AND BUILDING STUDENT

BY

WALTER R. JAGGARD

AND

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M.Sc.Tech., M.I.Struct.E., F.I.San.E.

Fourth Edition

(Revised and Enlarged by F. E. DRURY)

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GENERAL PREFACE

IN writing and illustrating the series of works on Architectural Building Construction of which this is the first volume, the authors have been actuated by the desires and objects which are briefly set out below.

That there are many existing books on Building Construction is a well-recognized fact; that some of them have excellent matter, and others have good illustrations is also duly acknowledged, but from a long experience in the practice of Architecture, both in England and the Colonies, and many years of teaching architectural principles and the science of building construction, the authors have been forced to the conclusion that something more in the way of Text books is needed for the following reasons.

1. Building Construction should not be divorced from the Principles of Architectural Design. Although it is sometimes true that we find an Architect who can design pleasing structures with little or no knowledge of building construction, it is an undoubted fact that a fine conception of noble architecture must be based upon an intimate and complete knowledge of the proper use of materials, the scientific and fit assembly of the varying units, and an honest and conscientious co-ordination of the work of Architect, Builder and Craftsman.

It may be argued that with the present day use of steel and reinforced concrete, together with other modern materials and methods, we are able to construct some most extravagant fancies in architectural design, which a few years ago would have been quite impossible. Whilst this is quite true, and illustrates the age in which we live, it is also true that the very great majority of our buildings to-day are still erected with the staple materials, such as concrete, brick, stone and timber.

2. For the creation of good architecture it is necessary to study the work produced by our predecessors, and not only the work of ancient civilisations and mediæval peoples, but the best work of more modern architects must be examined. This study is rendered comparatively easy of acquisition through the rapid and cheap

facilities offered for travel, and the many excellent books and illustrations which are constantly being published. Attention might here be drawn to the publication entitled, *The Development of English Building Construction*, written by Mr C. F. Innocent, and forming one of the volumes of The Cambridge Technical Series; its perusal will prove both agreeable and interesting. Is it possible to apply this method to the study of Building Construction? The authors have been impressed with this idea, and have endeavoured, with some success, to carry it out in their teaching. They have, however, found that in the earlier stages of education this must not be unduly pressed. For elementary students, the teacher should, to some extent, be dictatorial, and whilst selecting a well-proportioned and designed study as an example, should insist upon the construction being shown in a definite manner, although he knows that infinite variety, both in design and construction, is possible. With the more advanced student greater latitude is desirable, and in fact necessary. The authors have, therefore, impressed a certain amount of individuality in the subjects of the first two volumes, but they intend, as far as possible, in the third volume to select examples of established taste and architectural value to illustrate advanced principles of design, maintaining in some cases the constructional details given them by their designer or constructor, but in others, adapting the construction in accordance with modern methods and the more extended use of machinery.

3. Building Construction has hitherto been presented to the student in the form of isolated examples, which have no relation whatever to each other, and thus the knowledge obtained cannot be applied to the actual design of a building, even of the smallest dimensions, until a very much later date. Modern methods of teaching demand a greater cohesion. The authors have endeavoured during their teaching experience to obtain or formulate one building into which all the various items comprehended in each year's work could be fitly placed, but after many attempts it was found to be impracticable, and therefore two buildings were arranged, which embody, with few exceptions, all the items necessary for an elementary knowledge of building construction, thus enabling "teaching from the structure itself to be adopted rather than the selection of isolated examples on account of their simplicity."

This method has been adopted in the first two volumes, but whilst the authors disclaim any idea of presenting great architecture, they do claim that the buildings designed fitly express their purpose, and enable them in a more or less pleasing manner to assemble the different units of the building, and at the same time to inculcate a sense of completeness in the student's work.

4. The acquisition of a knowledge of Building Construction should rightly be a plant of slow but sturdy growth, and in the majority of Architectural and Building Schools the course of instruction covers a period of from three to five years. The first volume of this series is designed to meet the needs of the first year student, the second volume will provide more than is generally required for a second year course, while the third volume will cover a large field of advanced work.

5. The authors have often felt that the ordinary orthogonal presentation of examples of building construction does not sufficiently convey the solidity of the object to an elementary student, and as it is not possible for each student to have, or to make, models of the different units for himself—although such a course would greatly make for efficiency of study—the illustrations have to a large extent been shown in perspective, isometric or pictorial projection. Photographs might, and in some cases will, be used, but the camera, whilst giving a faithful representation of the object, cannot be used to show the construction of hidden parts. On this account dissociated isometric and oblique sketches have been freely used with some slight shading to indicate differing planes, but cast shadows have generally been avoided as tending to obscure the construction, which it is desired to show in the clearest possible manner. *It is not intended that study shall proceed by copying the pictorial drawings. These should be translated into plan, section and elevation, in the form of ordinary working drawings.*

It is strongly recommended that in all Architectural and Building Schools correct scale models—about half full size—of the different items should be made in such a way that the parts may be dissembled, and that the student should be encouraged and advised to study and measure these carefully, and make the usual orthogonal drawings, which are, after all, the media through which Architect, Builder and Craftsman convey their ideas and wishes to one another.

It is necessary to impress strongly upon a student in the early stages of his work, that his knowledge must be presented in a clear and unmistakable way and with some architectural character. A study of the first-named author's two volumes of Architectural and Building Construction Plates would be of material value in the conception and arrangement of drawings embodying the principles of construction.

Students should be encouraged carefully to complete all their drawings with full naming of parts, references, and adequate dimensions, and to ink-in and colour, or otherwise distinguish, the materials of construction. They will thus acquire the habit of thoroughness, which is of inestimable value to both draughtsman and craftsman.

In conclusion, the authors' chief endeavour has been to make these volumes of primary importance to students—architect, builder or craftsman—and since in this study, at least, they all meet upon common ground, although each with different aims and objects in life to accomplish, yet, each finding help and guidance herein, there is an augury of the future happy relations which should exist between those engaged in all the branches of the practice of architectural building.

W. R. J.
F. E. D.

June 1916.

PREFACE TO VOLUME I

THE object of the scheme adopted in this volume is to provide an elementary course of instruction in "Architectural Building Construction," by embodying all the forms of building detail which are necessary for such a course in "proposed buildings, their surroundings and appurtenances."

By elucidating the details of construction of a whole building, a student, in his earliest study of the subject, is brought into contact with the necessity for treating each element of a structure as a unit in a complete scheme, and the problems that arise therefrom in the choice and suitability of site, selection of material for the work, elementary rules of construction as laid down by building bye-laws, and harmony in the detail and conception of the structure.

We should also observe that such a scheme almost equally benefits the professional student and craftsman, because:

(*a*) The professional student is, at an early period, engaged in the preparation of complete plans and details of architectural buildings.

(*b*) The craftsman or artisan student is engaged in preparing (or assisting in the preparation of) detached parts, whose successful assemblage in the structure goes to make the "preconceived whole" of the architect's design. These "parts" have necessarily to be detached from their surroundings for their construction, but being made to fit they eventually become an integral part of the latter.

Further, it is part of the professional training of the architect to prepare himself to foresee the artisan's difficulties in realising his conceptions, thus developing his art on the lines of satisfactory craftsmanship. The study will further tend to the realisation of the need for good will and co-operation between the designer and constructor if a successful end is to be attained.

Order of procedure in practical work is made clearer and thus leads to a better idea of the supervision of work in progress and of the preparation to be made for one trade to follow another in the execution of the work. The need for combined setting out of architectural features involving two or more trades, in order to avoid error and confusion, is also easier of demonstration.

The volume to follow this will develop the work further, by the consideration of larger and better class buildings in urban areas, where more restricted conditions call for special care and treatment, in order to meet the requirements of public health.

A glance at the contents of this volume will show that no pains have been spared to give the information decided upon in the clearest possible manner.

As the authors hope that this volume may be considered worthy of adoption for technical class work as well as professional and private study, and from personal experience they realise that no volume giving information to be merely copied can be considered satisfactory, they have, by giving the information in the clearest pictorial fashion, *left the teacher at liberty to train his students to prepare orthogonal projections of the details supplied.* Copying can thus be avoided and the faculties of the students directed to the practical method of detailing, in order to present to others the knowledge they are presumed to have gained from the explanatory diagrams. A student would, in addition, do much freehand sketching in recording his impressions of practical examples submitted for his consideration.

Many details of the work will appeal to the students in a much more interesting way than the usual isolated details for class teaching.

One prominent feature of this kind is the setting out of dimensions for doorways, windows, intermediate spaces, and hence the complete external dimensions of the building, to suit brick sizes and the bond to be adopted.

The special consideration of building materials has been omitted in this volume, as we desire to encourage students to obtain their first knowledge of this important section by personal examination and experiment. It will then be possible to deal with their selection and application more logically and exhaustively in the subsequent volumes than would otherwise be the case.

A study of a companion volume in this series, *Experimental Building Science*, by Mr J. Leask Manson, B.Sc. Eng., will provide a satisfactory basis for our purpose.

The authors desire to make due acknowledgment of the assistance derived from the study of many valuable works, a list of which will be given in a later volume.

They desire also to thank the undermentioned firms for their kindness in supplying information relating to specialities and materials of construction, and for their interest in the preparation of this volume:

S. and E. Collier, Ltd, Reading, and The Ravenhead Sanitary Brick and Tile Company, Ltd, St Helens, Lancashire (*bricks and tiles*); Carter and Aynsley, Ltd, 214 Bishopsgate, E.C. (*door and window fastenings*); Walter Macfarlane and Co., Saracen Foundry, Glasgow (*cast iron gutters and down pipes*).

W. R. J.
F. E. D.

June 1916.

Preface to Fourth Edition

Advantage has been taken of the necessity for a reprint of this volume to make some slight changes and additions to the text and illustration. The following illustrations have been added:

A diagram showing the modern treatment of concrete foundations, without footings, due to the general use of Portland cement concrete. Two plates of diagrams showing some of the varied methods of building up the foundation for the modern type of plywood-faced flush door. Three plates giving details of the simple methods of constructing double-hung sliding sashes; these are arranged firstly to give a clear understanding of the essentials without confusion by the introduction of mouldings and other complications, and secondly to illustrate the use of tongued joints in assembling the sash boxes—again without introducing moulded linings. After studying these new drawings the elementary student will be able to grasp the more elaborately designed example of first-class construction which forms the main feature of the chapter on windows. It should be noted that double-hung sashes are still in great use for commercial buildings as well as houses. In many cases dwelling-houses are fitted with double-hung sashes on the ground floor and casements on the first floor. An example is also given of a modern three-light steel sash and finishings.

The chapter on stairs has been revised to introduce more economical methods of construction, especially in regard to stair strings, and the diagrams have been generally revised accordingly. Many of the general illustrations have been re-drawn and either revised in small details or clarified by firmer outlines.

Thanks are due to Mr R. A. Bix for valuable assistance in the preparation of drawings for this edition.

F. E. DRURY.

28 *March* 1938.

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INTRODUCTION

(For the student)

MOST students, before reaching the stage of education where the study of "Building Construction" has become their special object, will have passed through some course of preliminary study including mechanical drawing. Where this is the case, a student must already possess some knowledge of the form, value, care and use of drawing instruments.

We shall not, therefore, occupy space by teaching him the most elementary matters concerning drawing, but merely impress one or two points which need reiteration with many students.

(*a*) Remember that instruments, to be of any value, must be in good working condition. *This is your special care.* First-class instruments are always advisable, but they need to be kept in first-class condition for satisfactory work. Cheaper instruments *may* do satisfactory work if cared for.

(*b*) Keep everything you employ for drawing purposes *clean*—paper, board, squares, rubber and hands. Don't sharpen pencils *on the board.* Use good pencils sharpened to a *long* rounded point; flat or chisel points, while advisable for geometry, are not suitable for the production of architectural drawings, which necessitate a large amount of freehand work in the profiles of mouldings, lettering and dimensions.

(*c*) For work to be completed in pencil, don't use a hard lead. "HB" is hard enough and can be employed for all purposes.

(*d*) Obtain a soft indiarubber and keep it in a case, not in your pocket.

(*e*) *For class notes,* a note book 9″ × 5½″ faint ruled on one page and ⅛″ squared on the alternate page is suitable for elementary work.

For drawings, half imperial sheets are sufficiently large and satisfactory work can only be produced on paper of good quality.

(*f*) Study, under any conditions, must be *thorough* and *continuous.*

(*g*) The scales generally adopted for architectural work are ⅛″, ¼″, ½″ and 1″, and we recommend one instrument containing these scales on separate edges, known as the "Architect" scale, which is obtainable in boxwood or ivory.

Compound scales, having several scales on one edge, tend to confusion and error.

Cardboard scales are often not reliable and their edges quickly deteriorate with regular use.

(*h*) Every student of building construction should endeavour to attain a good standard of draughtsmanship; he can make little progress without it.

Ability to express one's thoughts clearly and fully whether in freehand or mechanical drawing is to acquire the "language" of the architect and builder. It is just as indispensable as speech. Clear freehand sketching forms a large part of his equipment in explaining his conceptions to others and can only be obtained by constant practice.

Students are also advised that they cannot make satisfactory progress in their studies as the work becomes advanced, unless they possess an adequate knowledge of practical mathematics, geometry and experimental science. Special attention should be paid to such parts of these subjects as are of vital importance in the design and construction of buildings. (See "Courses for building students" such as are generally available and also the companion volumes in this series.)

Description of the Buildings, the Construction of which is to be studied in this Volume

In the preface to this volume it has been pointed out that the authors at first desired to formulate one building into which could be fitly introduced the varying items usually comprehended in an elementary scheme of Building Construction, but the aggregation of conflicting details and doubtful combinations of materials would of necessity render such a building too complicated to answer the authors' main purpose, viz., to deal in the clearest possible way with forms of construction which may be fitly assembled in a comparatively simple structure.

With this aim in view they have therefore selected two buildings for study, one being a detached cottage of two storeys, built in brick and roofed with tiles, and suitably erected in a country district for the accommodation of a gardener, gamekeeper or some agricultural worker; the other, a single storied workshop built in brick and stone, having a slated roof and overlooking an open yard. The workshop might reasonably be erected on the outskirts of a provincial town for the accommodation of a plaster worker, a stone or marble carver, or any craft desirably housed in a building presenting some architectural character.

It is not intended that these two buildings should have any relation to each other, nor is it contended that they are suitable for erection in all districts. The authors rather desire to impress upon students the need for careful study of local materials, and their preferable use where suitable, in order to avoid the importation of foreign materials with their attendant cost.

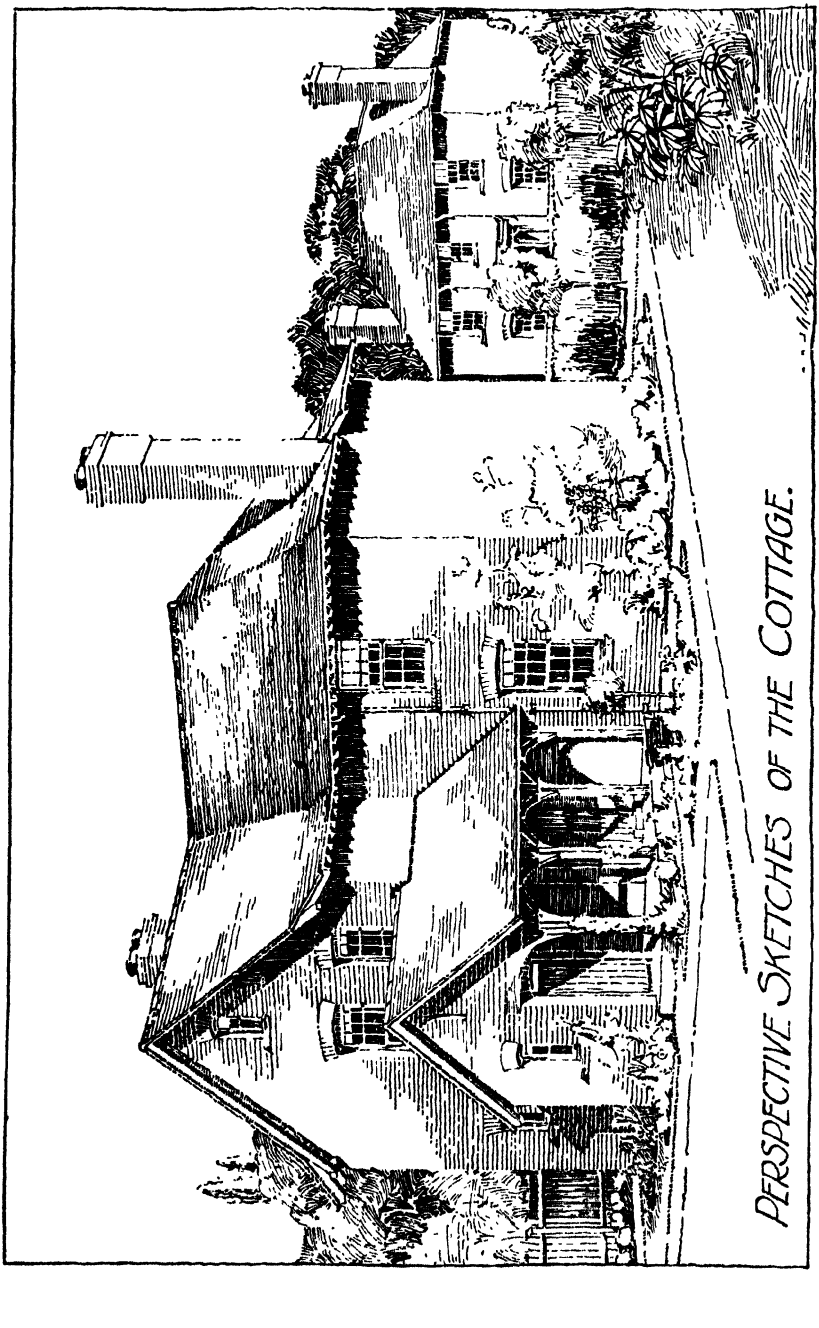
The Cottage

The cottage is detached and, as will be seen from the general working drawing in pocket of binding, consists of a two-storied main block, L-shaped in plan and covering a superficial area of about 966 square feet with a small one-storied back addition having a superficial area of approximately 120 square feet.

Externally the walls are built of brick in Flemish bond, the ground floor walls of main building being 1′ 1½″ thick, while the upper floor walls and those of the back addition are 9″ thick. The window openings have brick cills, and brick arches surmount both window and door openings. All the roofs are covered with plain tiles, and are supplied with cast iron gutters and rain water down pipes. The majority of the windows are fitted with sliding sashes, but the scullery, larder and earth closet windows have solid frames and casements. A small open porch, finished with a flat lead-covered roof, is placed as a protection around the main entrance doorway, while a covered way forms a part of the back addition and provides a sheltered approach from the scullery door to the tool store, fuel shed and earth closet. This covered way is paved with concrete, but the porch is finished with brick paving.

The accommodation of the cottage is as follows: On the ground floor. An entrance lobby, 5′ 7½″ wide by 4′ 6″, with the stairs to the upper floor directly opposite the entrance door; the lobby contains two doors, the one on the right leading into a sitting room or parlour, 14′ 3″ × 13′ 9″, which has a boarded floor, one window, a fireplace and a large recess; the other door leads into a large living room, 18′ 9″ long by 14′ 3″ wide. It also has a boarded floor, two windows, a large fireplace, and a recess opposite, which might suitably contain a dresser. Another door from this room leads into a scullery, about 18′ 0″ long by 9′ 3″ wide, with a recess 7′ 6″ wide by 3′ 4½″ deep, in which could be placed a sink. This room is lighted by two windows and is to be paved with concrete. Doors from this room lead into a large store cupboard arranged under the stair to the upper floor, and into a larder, 5′ 3″ × 3′ 0″, containing shelves and lighted and ventilated by a casement window. Another door from this room forms the back entrance to the cottage and leads, by means of a covered way, firstly to a tool store, 5′ 3″ × 3′ 0″, which is arranged to balance the larder on the plan, thence to an open fuel shed, 6 feet square, and finally to an earth closet, 5′ 6″ × 3′ 0″, lighted and ventilated by a casement window. The floors of these latter are finished with cement on a concrete base.

Returning now to the entrance lobby; a stair 3′ 3″ wide, and containing 15 steps, leads in a straight flight to the upper floor



PERSPECTIVE SKETCHES OF THE COTTAGE.

CHAPTER ONE

BRICKWORK

Terms Employed—Bonds

1. Bricklaying is the craft of laying and lapping comparatively small units of "brick," for the purpose of producing a well united mass of any desired form, and such a mass of material efficiently united is known as brickwork.

Brick is an artificially prepared building material made by baking or burning prepared clay or shale, and is used as a substitute for other materials found in a natural state and more or less suitable for building purposes. It is easily and economically prepared by modern machinery and is in common use in most districts where natural stone is not obtainable cheaply and plentifully.

To facilitate the laying of bricks, each kind is made in some "regular size," and proportioned to allow of some particular method of setting them.

The arrangement necessary to unite the pieces of brick by lapping one over another is called "bond."

There are many ways of doing this, hence there are many "kinds of bond." Some of these embody the good qualities of bonding to an almost perfect extent, while others, for convenience or economy, fall short of the ideal bond in varying degrees.

Thus variety of bond may arise from:

(*a*) A desire to vary the surface appearance.

(*b*) A demand for the greatest possible strength.

(*c*) A desire to produce an economical structure sufficiently strong and durable for a required purpose.

Bonding is dependent on the relative dimensions of the bricks employed, hence we must first consider these.

2. Sizes of bricks. Although bricks vary in size with locality and custom, a standard size of ordinary building brick has become fairly established in this country, due to an arrangement between the Royal Institute of British Architects and brick manufacturers.

The dimensions adopted are: minimum, $8\frac{7}{8}'' \times 4\frac{5}{16}'' \times 2\frac{5}{8}''$, maximum $9'' \times 4\frac{3}{8}'' \times 2\frac{11}{16}''$, and to rise four courses to one foot. These

dimensions are intended to ensure ease of handling, facility for bonding and satisfactory burning; see detail No. 1.

In common brickwork the mortar joints are usually $\frac{1}{4}''$ to $\frac{3}{8}''$ in thickness, which enlarges the dimensions of a brick of the minimum size above to, say, $9\frac{1}{8}'' \times 4\frac{9}{16}'' \times 2\frac{7}{8}''$, assuming the thinner joint and measuring centre to centre of joints. This gives an awkward set of dimensions for drawing.

When drawing bricks laid in position, it is necessary to adopt convenient dimensions for the purpose; these are generally $\boxed{9'' \times 4\frac{1}{2}'' \times 3''}$ and are a very close approximation to actual dimensions for many bricks, which are made $8\frac{3}{4}'' \times 4\frac{1}{4}'' \times 2\frac{3}{4}''$, a very convenient set of dimensions for $\frac{1}{4}''$ joints.

Observe that in the pictorial illustrations which follow in this chapter the joints are represented by double lines, in order to make clear and duly emphasise the detail of bonding.

The reason for the relation of length to breadth in the sizes adopted is, that in the crossing of bricks in the standard bonds two "brick widths" need to make a "brick length" on the face of the finished wall; hence "a brick length must be twice its width, plus the thickness of a mortar joint." This rule may always be adhered to; it cannot conveniently be varied.

The relation of thickness to other dimensions is not so important, and such variations as may be found in certain localities are chiefly in the "thickness." A standard thickness such as the one quoted above is useful in deciding the number of courses required for a given height.

In the north of England it is very common to find bricks rising four courses to 13″, or even more in the case of cheap work. Their appearance leaves much to be desired, uniformly thin courses being preferable to the deeper ones, except in large buildings.

3. Bond. In proceeding to the detailed consideration of bond we need to make continual references to terms in common use, which may be defined as follows:

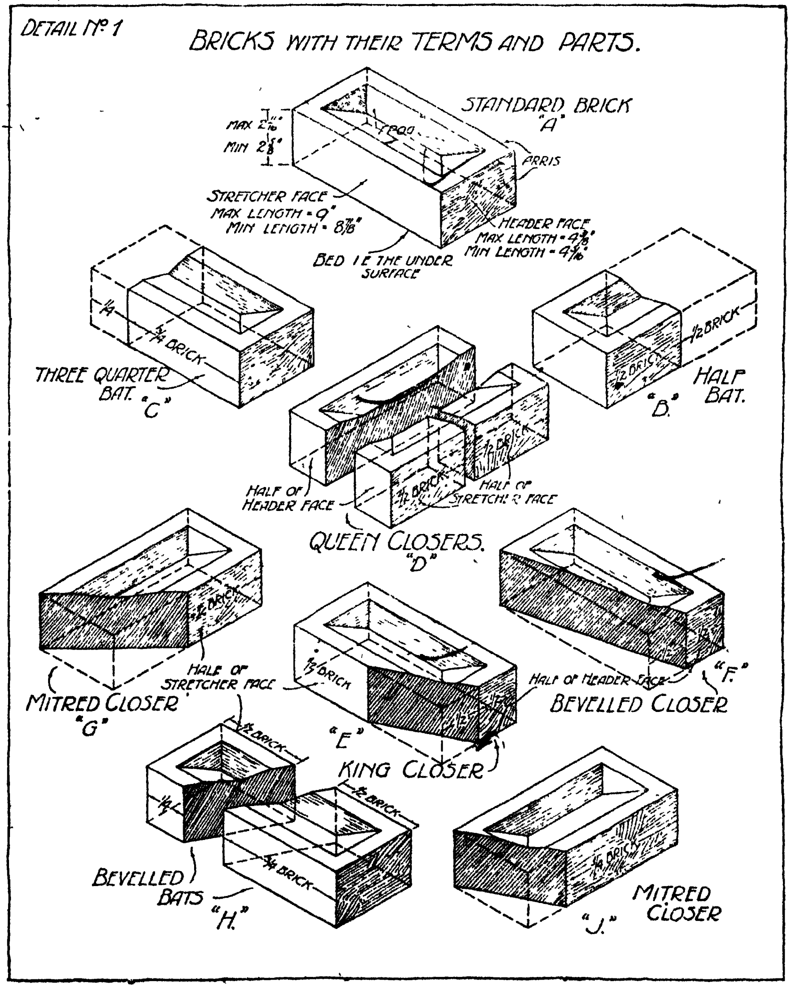
"Header"—a full brick, placed to show its "end" ($4\frac{1}{2}'' \times 3''$) on the face of the wall, or, having its end "parallel" to the face.—Detail 2 B.

"Stretcher"—a full brick, placed to show its "side" ($9'' \times 3''$) on the face of the wall, or, having its side "parallel" thereto.—Detail 2 B.

"Bat"—a broken (or cut) brick, being $4\frac{1}{2}'' \times 3''$ by some fraction of the length; *e.g.* $\frac{1}{2}$ bat is half length ($4\frac{1}{2}''$), $\frac{3}{4}$ bat is three-quarters of the length ($6\frac{3}{4}''$).—Details 1 B and 1 C.

"Closer"—a portion of a brick cut and placed to obtain a correct start in setting the bond on the face of a wall.

"Queen closer"—half of a brick obtained by dividing the width; the "end" is $2\frac{1}{4}''$ × $3''$ and shows on the face of the wall, or is parallel to it.—Detail 1 D.



"King closer"—a brick reduced to a width of $2\frac{1}{4}''$ at one end by cutting off the triangular piece between the centre of one end and the centre of one side.—Detail 1 E.

This term is also employed in some parts of the country to include all "bevel cut bricks" of whatever shape.—Details 1 F to 1 J. We shall distinguish between these forms to prevent confusion.

"Bevelled closer"—has one end reduced to 2¼″ wide by bevelling the whole length of the brick while maintaining the full width at the other.—Detail 1 F.

"Mitre bricks and mitred closers"—have their ends cut to mitre together. At a right angle the amount removed is 4½″ each way from end and side, leaving a sharp edge, which is usually badly cut.—Details 1 G and 1 J.

"Bevelled bats"—bricks of less than their original length at every part, retaining their full width and cut across on the bevel. —Detail 1 H.

"Arris"—the sharp edge at the intersection of two faces, commonly termed the angle.—Detail 1 A.

"Bed"—the surface of the brick on which it rests, or upon which another brick is supported. Usually the horizontal surface, 9″ × 4½″. —Detail 1 A.

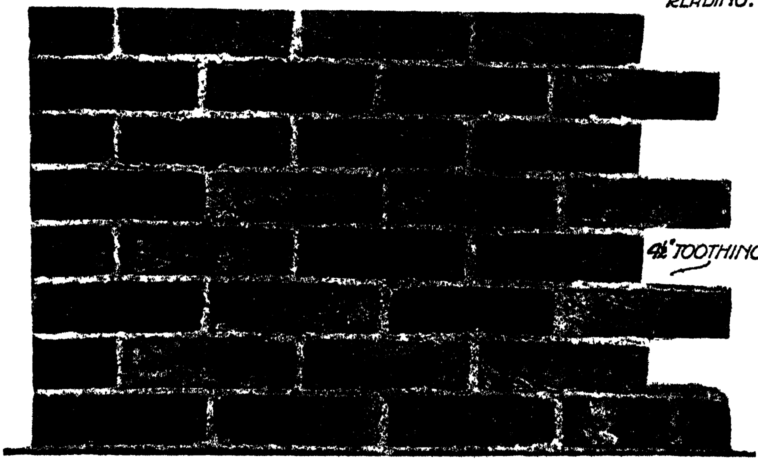
"Frog"—a depression in the bed whose purposes may be:

(*a*) To lighten the brick and economise material.

(*b*) To provide a recess for the mortar which, when set, helps to prevent displacement of any brick from the adjacent ones.

(*c*) To make it easier to bring the bed surfaces closer together. These surfaces become narrow bands and are not so liable to irregularities.—Detail 1 A.

DETAIL Nº: 2.A. PHOTOGRAPH SUPPLIED BY S. & E. COLLIER. LTD. READING.



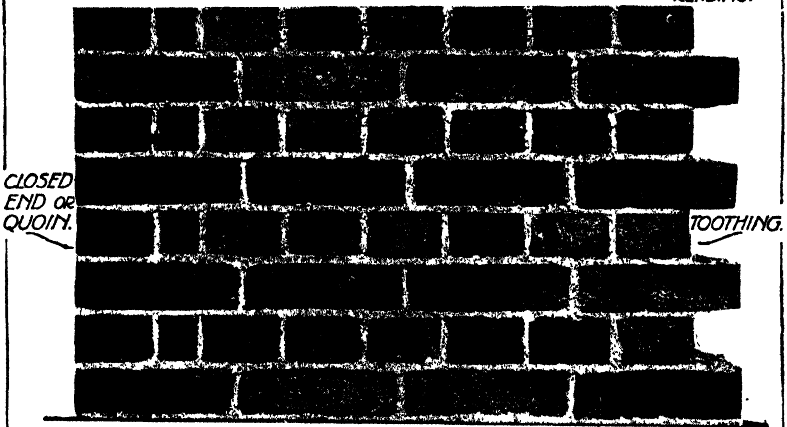
STRETCHING BOND. ALL STRETCHERS IN EACH COURSE.

Wire cut bricks have "no" frog.
Hand made bricks have "one" frog.
Semi-dry machine made bricks have usually "two" frogs.

"Face"—any one of the vertical surfaces of an ordinary brick; a 9″ × 3″ surface is called a "stretcher face" and a $4\frac{1}{2}$″ × 3″ surface a "header face."—Detail 1 A.

"Course"—one continuous layer of bricks of the same thickness and laid on the same surface.—Detail 2 B.

DETAIL Nº: 2B. PHOTOGRAPH SUPPLIED BY S.&E. COLLIER. LTD. READING.



ENGLISH BOND.
ALTERNATE COURSES OF STRETCHERS AND HEADERS.

"Perpend"—the line of vertical joint on the face of a wall. We are said to keep the "perpends" true, when the vertical joints in alternate courses form "parts of one vertical line"; they stand truly over each other.—Detail 2 C.

"Straight joint"—occurs when two consecutive vertical joints are in the same plane. Straight joints should never occur on the face of a wall; they *do* occur in short lengths within the wall in certain kinds of bond and occasionally near stopped ends and angles.

The fewer straight joints, the better the bond.

The bonds in common use are "stretching bond," "English bond," "Flemish bond" and "garden bonds." In every case the varieties of bond are named and distinguished by the "face arrangement" of their courses.

4. Stretching bond. Is used for $4\frac{1}{2}$″ walls only; all courses are stretchers lapping half their length over adjacent bricks upon which they rest.—Detail 2 A.

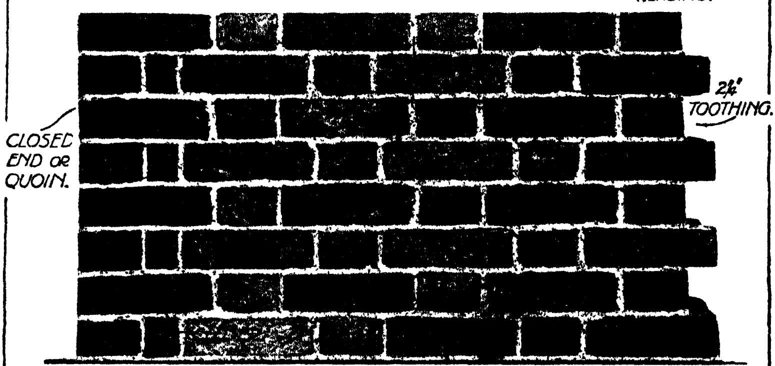
These $4\frac{1}{2}''$ walls are also known as "half-brick" walls, and in the north of England as "single" brick walls.

5. English bond has the mass of the work laid in *alternate courses* of headers and stretchers on the face.—Detail 2 B. One header is centrally over the stretcher; its neighbour overlaps the stretcher joint equally on each side. The minimum lap is therefore $2\frac{1}{4}''$.

6. Flemish bond has *alternate bricks* laid as header and stretcher in "every course."—Detail 2 C. Each header is centrally placed between the stretchers immediately above and below.

The term "double Flemish bond" means that both faces of a wall show the Flemish arrangement.

DETAIL No: 2.C. PHOTOGRAPH SUPPLIED BY S.& E. COLLIER. LTD. READING.



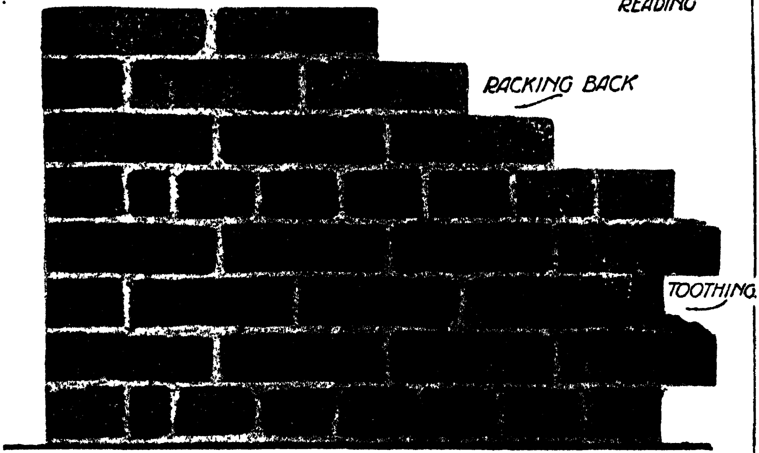
FLEMISH · BOND.
STRETCHERS AND HEADERS ALTERNATELY IN EACH COURSE.

7. Garden bond. Accepting English and Flemish bonds as the principal ones in common use, we may define garden bond as an imperfect variation of either of these types. These variations are cheaper, less laborious to build when two fair faces are required, and most suitable for walls $9''$ thick, *e.g.* garden and boundary walls.

The two varieties of garden bond are:

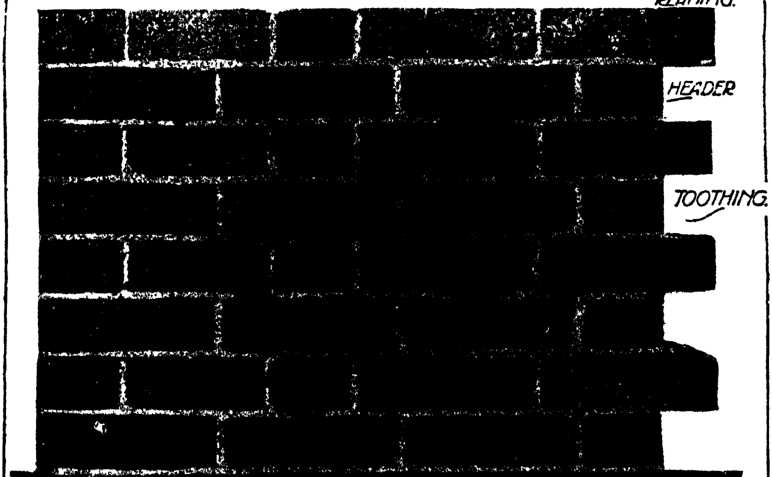
"English garden bond," which has the same "general arrangement" as English bond except that the heading courses are only inserted at every "fourth" or "sixth" course. Commonly we have *one* course of headers to *three* courses of stretchers. The stretching courses are bonded as in ordinary stretching bond and are quite detached from each other vertically between the heading courses. —Detail 2 D.

DETAIL No: 2.D. PHOTOGRAPH SUPPLIED BY S. & E COLLIER LTD. READING



ENGLISH GARDEN WALL BOND:
THREE COURSES OF STRETCHERS TO ONE COURSE OF HEADERS.

DETAIL No: 2.E. PHOTOGRAPH SUPPLIED BY S. & E COLLIER LTD READING.



FLEMISH GARDEN WALL BOND. THREE STRETCHERS TO ONE HEADER IN EACH COURSE.

"Flemish garden bond" has the same nature of variation, viz., the quantity of stretchers is increased and *three* stretchers are laid to *one* header in each course, the latter being always laid in the centre of the middle stretcher of the series.—Detail 2 E.

Note. English garden bond is in very common use; Flemish not so common, in some districts quite unknown.

8. Comparative value of "English," "Flemish," and "garden" bonds. If a wall be more than $4\frac{1}{2}''$ thick we have the choice of these three bonds for ordinary continuous walling.

Garden bond is suitable for one brick (9″) walls only, is quickly laid to obtain two fair faces, but is deficient in strength "crosswise" and liable to bulge at the stretching courses, if loaded too heavily.

It is used because other bonds are more difficult to lay for one brick walls if two fair faces are required, owing to the bricks varying in length. If comparatively few headers are needed they may be conveniently selected from the supply to obtain uniform length. The thickness of a wall is then determined by these selected headers and the stretching courses made flush with the header faces.

English bond is, all things considered, the strongest bond obtainable. It ties the wall efficiently lengthwise and crosswise and has no serious deficiency except in thick walls; there are no straight joints in the mass of the walling. Its appearance is also very good.

Deficiencies in thick walls are referred to in Vol. II.

Flemish bond is defective in strength as compared with English, yet sufficiently well bonded for all general purposes. It contains numerous straight joints $2\frac{1}{4}''$ long which somewhat detract from its strength. See detail No. 3 B. Its chief asset is popularly said to be its "face appearance," though this is a debatable point and a matter of personal preference.

Examine details Nos. 2 B and 2 C and observe practical examples of these two bonds; you may then decide for yourself which "pattern" you prefer.

As our chosen structures contain examples of stretching, English, Flemish and garden wall bonds we shall speak of them in detail as they arise, but as a preliminary to the consideration of the applied details, it is wise to become thoroughly acquainted with the simpler arrangements and further practical terms.

Refer to the illustrations on details Nos. 2 B and 2 C.

The elevations of walls in English and Flemish bonds are shown together here to allow comparison. They are to be employed respectively in the workshop and cottage. Each has a "square stopped end" which necessitates a study of the means employed to obtain

a start for the bonding. Observe that in every "stretching" course of the English bond the bricks are laid as stretchers throughout, but in the heading course, in order to ensure the correct position of the headers in the mass of the work, viz. each central over the stretcher below, a "queen closer," $2\frac{1}{4}''$ wide, is placed immediately after the first header.

In English bond, it throws the succeeding header $2\frac{1}{4}''$ over each stretcher below it, and the next header centrally over the stretcher.

In Flemish bond the "stretching course" is the one *commencing* with a stretcher and contains header and stretcher alternately throughout. The "heading course" commences with a header, and is immediately followed by a closer which throws the succeeding stretcher forward to overlap the header below equally at each end.

When commencing a heading course at a stopped end, we may therefore establish the following rule: *place a closer immediately after the first or quoin header in the course.* Stretching courses contain no closers at the stopped end on the *faces* of the wall.

Whatever the thickness of a wall the elevation for one kind of bond is practically constant. The change in thickness does, however, alter the plan arrangement of the courses for, as the thickness increases, difficulties of bonding arise due to maintaining the features of the bond at the "face of the stop," and to odd half bricks in the thickness.

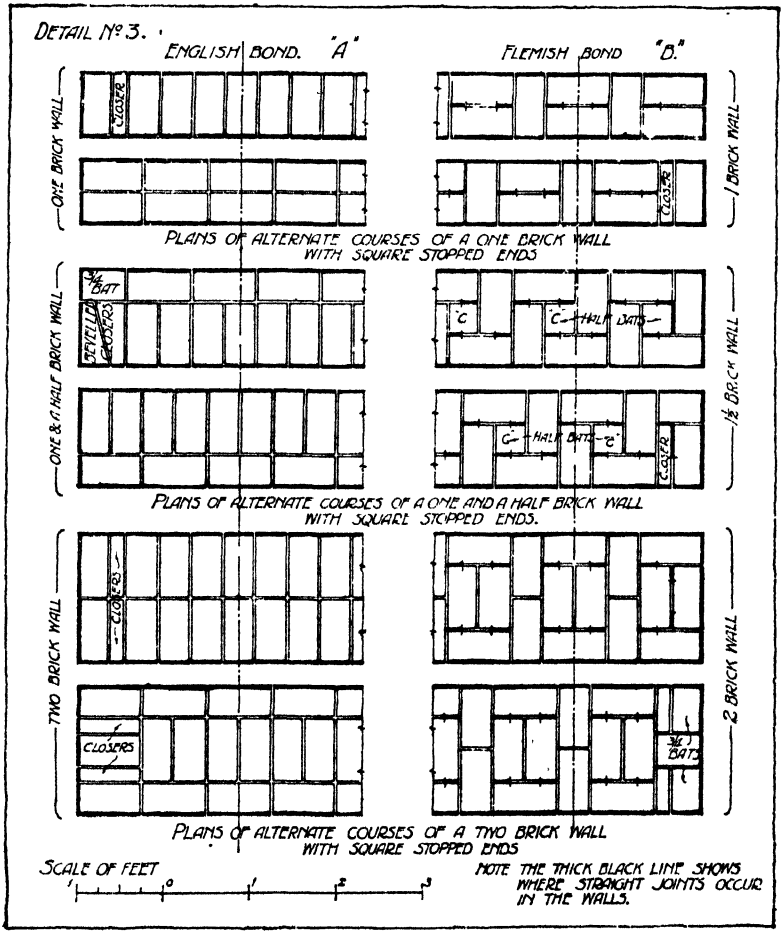
9. English bond plans. Detail No. 3 A shows the method of bonding walls up to 18″ thick in English bond. The 9″ wall should need no explanation. Our only remark concerning it is, that the queen closer shown $9'' \times 2\frac{1}{4}''$ would, with common bricks, be in two pieces $4\frac{1}{2}'' \times 2\frac{1}{4}''$ because it is difficult to cut a brick lengthwise without snapping it across. A short vertical joint might therefore occur at the centre.—See sketch at detail No. 1 D.

In the $13\frac{1}{2}''$ (one and a half brick) wall the courses have stretchers on one face and headers on the other, which is the only economical arrangement resulting in a strong wall. It is always adopted in walls whose thickness is in odd half bricks, but it is essential that two headers should coincide in width with one stretcher. The stopped end is formed by one $\frac{3}{4}$ bat and two bevelled closers in one course and by the usual unit in the other: alternative methods are available which you should endeavour to discover.

The 18″ (two brick) wall demonstrates the general principle of setting the bricks in a thick wall with a stopped end. Stretching courses are invariably laid with stretchers on the faces of the wall and the centre filled with headers in order to keep the "cross-tie"

adequate for the work of concentrated loading. (This principle causes deficiencies in very thick walls—see Vol. II.)

A stopped end in a wall 18″ thick or more is treated in bonding as a separate narrow wall. Its "face headers" become "stretchers"



on the end and similarly "face stretchers" become "headers," the intervening space between them being filled with headers and the requisite "spacing closers."

10. Flemish bond plans. Detail No. 3, on the right, demonstrates the difference between English and true Flemish bonds.

The 9″ wall has the closer following the first header in the heading course. This secures the necessary spacing.

Walls 13½″ thick are more difficult to bond. The lower course is the "heading" course. On the face it commences with a header, followed by a queen closer and a stretcher. At the back, a ¾ bat fills the angle and is succeeded by a header. As the alternate headers and stretchers are laid, a square opening marked *C* continually occurs and is filled with a ½ bat.

The courses consist of square units, 1½ bricks side, the margin of which consists of whole bricks and the centre a ½ brick square. In alternate courses these squares are stepped to the right or left until the header of one course is central with the stretcher below. This arrangement is economical and the only defect is a succession of 2¼″ lengths of vertical straight joints at the overlap of "stretcher on stretcher."

The 18″ wall has its alternate headers and stretchers symmetrically arranged on the two faces and the spaces filled with headers as in English bond.

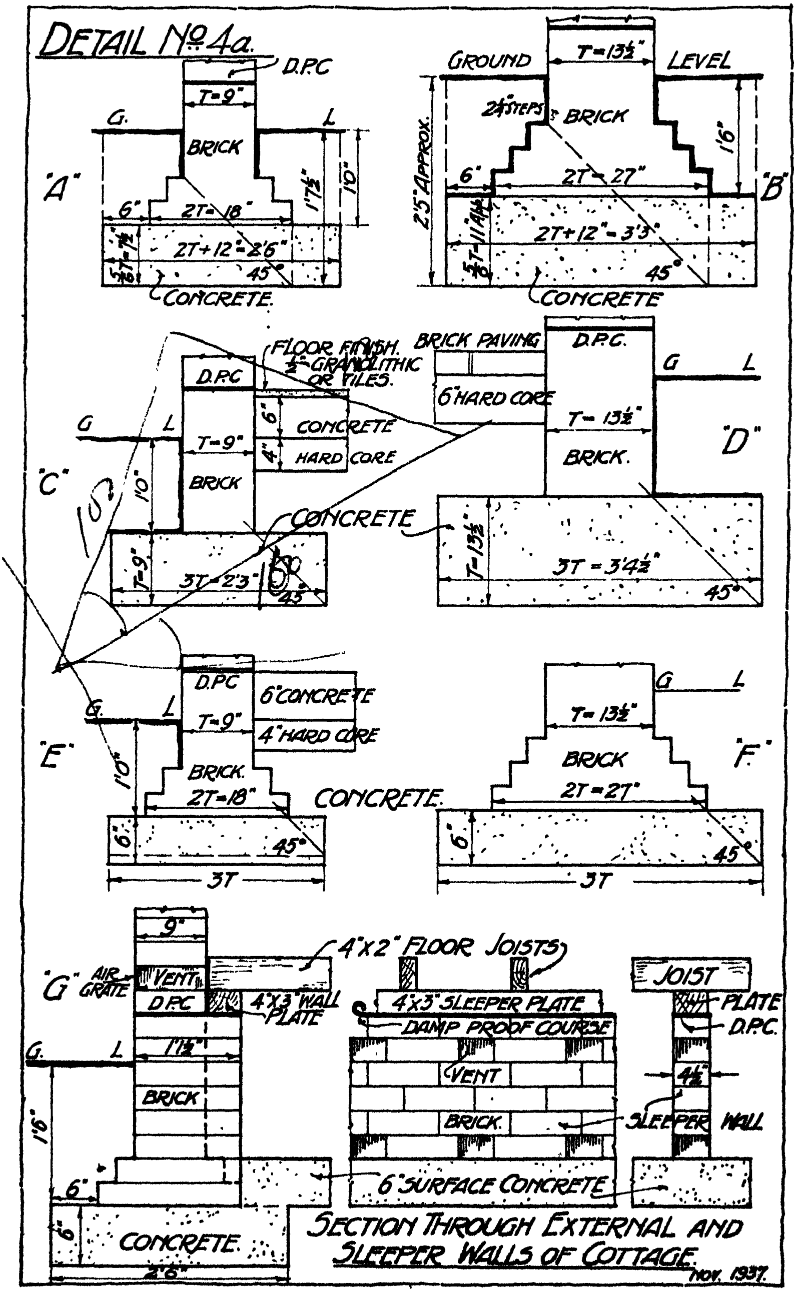
Note that the "end" of a wall, and the angle or quoin at a change of direction in plan, are the weakest parts and the bonding should therefore be as perfect as possible.

11. Toothing. Details Nos. 2 A to 2 E illustrate two methods which provide for addition to and continuation of walling.

When a wall is stopped with the intention of making some future addition to its length, the bonding must continue if the longitudinal connection is to be sound. Instead of bonding for a stopped end in such cases, the end of the wall is left with a toothed end preferably with the stretcher bricks projecting 2¼″ for the purpose of "tailing in" future courses.—See details Nos. 2 A, 2 B and 2 C. Sometimes the dimensions will not allow the stretchers to finish the required length, then the headers have to serve the purpose, although they are weaker, liable to displacement and awkward to lay.

During the procedure of bricklaying it is often desirable to carry one part of the building up in excess of another and again, in regular practice, it is common and wise to build up the "quoins" of a wall first to a height of several courses and to fill in the mass of straight work between them to a line. The "ends" of the primary work at the quoins are left more or less as at detail No. 2 D, with the bricks forming steps which allow of easy filling in. This step formation is called "racking back" and is properly racked when no upper course contains a brick projecting over the end of a course below.

12. Garden bonds are illustrated in elevation in details Nos. 2 D and 2 E and should be clear from previous references. These bonds are applied in the boundary walls of the "workshop yard."


DETAIL No 4a.
D.P.C
T=9"
G. L
BRICK
"A"
6" 2T=18"
1'7½"
1'0"
2T+12"=2'6"
45°
CONCRETE.
GROUND T=13½" LEVEL
2¼" STEPS BRICK
2'5" APPROX.
1'6"
6" 2T=27"
"B"
2T+12"=3'3"
45°
CONCRETE
FLOOR FINISH. ½" GRANOLITHIC OR TILES.
BRICK PAVING
D.P.C.
D.P.C
6" CONCRETE
4" HARD CORE
6" HARD CORE
G L
T=9"
T=13½"
"C"
1'0"
BRICK
BRICK.
"D"
CONCRETE
T=9"
3T=2'3"
45
T=13½"
3T=3'4½"
45°
D.P.C
6" CONCRETE
4" HARD CORE
G. L
T=9"
"E"
1'0"
BRICK.
2T=18"
CONCRETE.
6"
45°
3T
T=13½"
BRICK
"F"
2T=27"
6"
45°
3T
9"
4"x2" FLOOR JOISTS
JOIST
"G" AIR GRATE
VENT
D.P.C
4"x3" WALL PLATE
4"x3" SLEEPER PLATE
PLATE
DAMP PROOF COURSE
D.P.C.
G. L
1'1½"
VENT
4½"
BRICK
BRICK.
SLEEPER WALL
1'6"
6"
6" SURFACE CONCRETE
6"
CONCRETE.
2'6"
SECTION THROUGH EXTERNAL AND SLEEPER WALLS OF COTTAGE.
Nov. 1937.

CHAPTER TWO

BRICKWORK

Foundations and Footings

13. When the walls of a structure are to be erected upon natural ground, the soil on which the building rests must be capable of supporting the load which may be placed upon it.

For work of the dimensions included in this book, *any* good dry soil will afford adequate support if one of the forms of foundation shown in detail No. 4a be adopted.

A *natural foundation* is the ground directly supporting any artificial fabric resting upon it.

The term *foundation* is, however, commonly applied to that part of the artificial construction in contact with, and deriving its support from, the ground. In earlier buildings it was often an extended base to a wall and of the same material—*e.g.* brick or stone—but is now, almost invariably, a bed of concrete in one continuous mass, laid upon the earth at the bottom of an excavation for a wall, or pier.

In modern work, particularly for buildings of two or three storeys, walls are erected directly upon the concrete without any increase in width at the base to form footings. This arrangement is shown at C and D in detail No. 4a for 9″ and 13½″ walls respectively. A satisfactory proportion for the foundation is to make the thickness of the concrete equal to the thickness (T) of the wall, and the width of the concrete equal to $3T$.

Footings. For first-class work—and for buildings of greater height and weight—footings are used. These are stepped courses, having a width of $2T$ at the base, laid on the concrete, and stepped inwards by 2¼″ offsets on each side until the thickness of the main wall is reached. See detail No. 4 and also No. 4a at A and B. In this case the concrete is made to project 6″ at each side of the footings and the width of the concrete is therefore $2T + 12''$.

In modern small buildings if footings *are* used for some reason, the concrete bed need not be so thick as when the wall is commenced directly from the concrete. The arrangement is shown at E and F in detail No. 4a. At E the thickness of concrete obtained by drawing a line at 45° to the base from the edge of the footing would be 4½″. A minimum of 6″ should, however, be adopted for any foundation of this kind.

The reasons for a foundation to an ordinary wall are:

(*a*) To make a level bed from which building operations may conveniently commence.

(*b*) *To spread the base of the wall sufficiently to distribute the weight over a large enough area of ground and prevent "tilting" of* the wall or undue settlement.

(*c*) To bridge over any faulty places in the "natural foundation" —such as soft patches—in order to avoid settlement above them.

The latter statement will make it clear that the depth of the concrete must be increased as the load upon the foundation increases, in order to prevent the concrete bed giving way beneath the load at the softer patch of ground.

Usually, the minimum depth is 10″ for main walls and we shall show how the depth may be proportioned to the thickness of wall and projection of footings, when studying the detail of our buildings.

14. Light walls. Light boundary walls to yards and gardens which enclose and divide properties are often built with footings directly upon the earth, levelled to receive them at a depth of 12″ from the surface.

On good dry ground, not subject to much disturbance by rain, this may succeed for a period, but their condition is always precarious and it is wise to provide a foundation to prevent ultimate settlement and disturbance. The result of *not* doing so is usually evident after a time in walls tilted out of the vertical, and junctions and angles with cracks and flaws.

15. Materials for foundations. Concrete is in most common use. It is made from lime or cement, sand, and rough hard material broken to pass through a circular ring $1\frac{1}{2}'' \times 2''$ diameter or through $1\frac{1}{2}''$ square meshes, and prepared by mixing the materials in a dry state, then wetting and further mixing until a composition is obtained which is plastic enough to place in position and ram solid. Suitable proportions are: 1 part cement, 2 parts sand, 5 or 6 coarse parts material measured by volume. 1 : 3 : 5

16. Foundation walling. The portion of any wall between the top of its footings and the surface of the ground—or to the basement floor level where such exists—is termed "foundation walling."

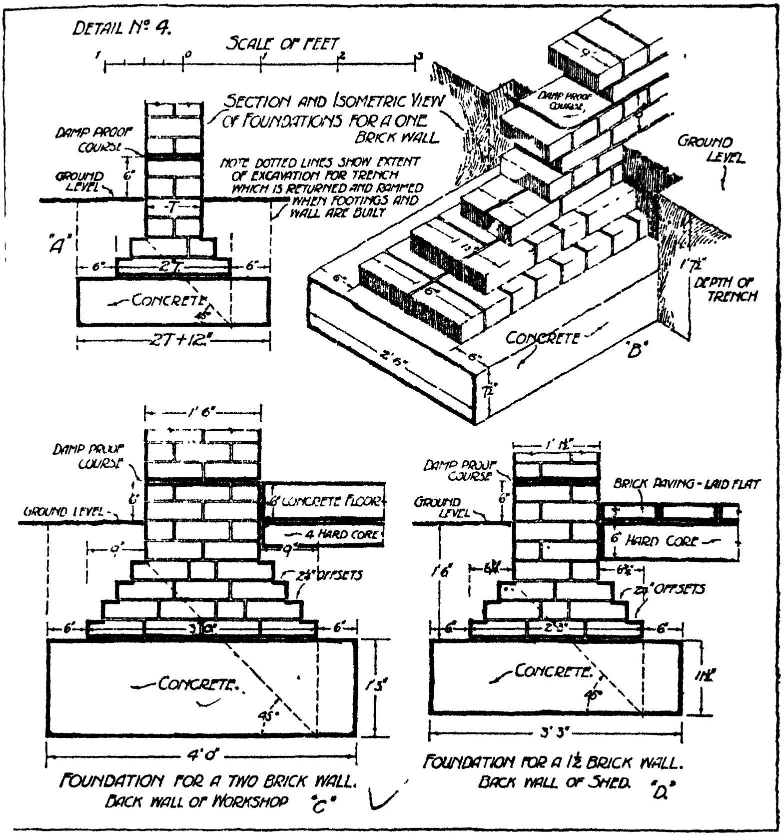
Footings and foundation walling should be of sound hard burnt bricks, absorbing very little moisture, and should be set in hydraulic lime or cement mortar.

Their form and colour are not important, but imperfectly burnt bricks should not be used.

17. Foundations to the walls of cottage and workshop. We shall now consider these in detail.

Detail No. 4 supplies the dimensioned sections of the workshop foundations and footings, with the foundation walling and main wall a little above the ground level. An isometric view of the 9″ wall is also shown.

The first process in laying out foundations is to decide at what distance below the ground level the concrete foundations shall be placed, measured to their "upper" surfaces. On a level site, or one with little slope, all the outer walls and the principal internal ones (over 4½" thick) may advisably start off the same level. The depth



FOUNDATION FOR A TWO BRICK WALL. BACK WALL OF WORKSHOP "C"

FOUNDATION FOR A 1½ BRICK WALL. BACK WALL OF SHED. "D"

f this below the surface varies with conditions, but we have selected 3" as the least depth for the bases of the footings below the ground, ence the concrete beds must finish to this level, whatever thickness ley are required.

Every section of wall base and foundation may therefore be set it as follows:

Place the ground level in the desired position and draw the level r the top surface of the concrete. Erect the centre line of the wall, easure half thickness on each side, add projection of footings and concrete. Insert footings in 2¼" steps, add main wall and the

perpendiculars enclosing width of concrete, and to obtain the depth of concrete, draw a line at 45° from one edge of the wall base downwards to intersect a vertical line dropped from the opposite edge of the bottom course of the footings. For application of this principle see details Nos. 4 to 10.

18. Bond in footings. Our previous consideration of bonding ordinary brickwork has left us with the general idea of alternating headers and stretchers either in courses or in successive bricks. We cannot successfully follow this principle in connection with footings, because of the successive offsets in the courses, and the small tie obtained when "stretchers" are allowed to project 2¼″ beyond the succeeding course. Such bricks are liable to be tilted and detached from the mass if the wall should "heel over" under side pressure.

"Heading bond" is therefore the rule for footings, each brick entering the wall 6¾″ wherever possible, and therefore well tied into the "thickness." The longitudinal lap is 2¼″ at every brick and appears small, but the "bonding" and "weight" of the walling above secure the footings lengthwise.

When a course is an odd number of half bricks in width it should be treated as follows:

(*a*) If more than 18″ wide the odd half brick is filled by stretchers, as near the centre of the wall as possible.

(*b*) If 13½″ wide, two courses of ¾ bats would serve the purpose well, though very wasteful. The better method is to put the stretcher alternately on the inner and outer faces of the course. See detail No. 4 B in the second course of footings.

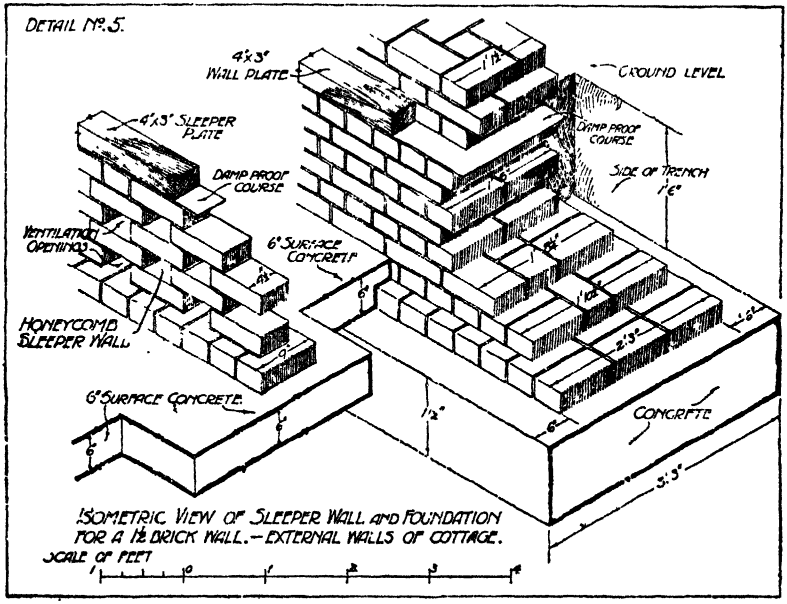
19. Footings to piers. In square piers the courses are crossed —alternately headers and stretchers—as in continuous walls, because the pier is liable to fail by tilting in either direction. This principle is further explained and illustrated at page 34. The above principles relating to the construction of footings will be found embodied in all the details of bases to walls Nos. 4 to 10.

Examine the isometric sketch, detail No. 4 B. This shows the position and relation of the parts clearly. It refers to the 9″ yard wall to the workshop and its footings are therefore 18″ wide and the concrete bed 30″. Being a boundary wall observe that its foundation is not so deep as the main wall foundations. The foundation trench would therefore be 2′ 6″ wide and 1′ 7½″ deep. Concrete is first laid and carefully levelled, then, after a sufficient time for setting has elapsed, the footings are laid. Notice here that the extra width of concrete bed—over the breadth of the footings—serves for the bricklayer to stand upon when erecting the footing courses.

The base course consists of two rows of headers, followed by a 13½″ wide covering course of "headers and stretchers." Upon the

footings the wall commences with either a heading or stretching course as may be convenient. In this case there is no advantage of one over the other, but in all cases the starting course should give the best bond obtainable.

20. **Damp proof course.** At a height of not less than 6″ above the ground level a layer of impervious material is laid across the wall, completely covering the brickwork below that level, and preventing moisture rising by absorption from the earth through the footings and foundation walling. It is called a "damp proof" course, and its function is to prevent damp reaching the woodwork of the floors and to maintain a dry and sanitary condition of the interior.



ISOMETRIC VIEW OF SLEEPER WALL AND FOUNDATION FOR A 1½ BRICK WALL.—EXTERNAL WALLS OF COTTAGE.

Damp proof courses are made of many materials, of which the following is a short list:

(*a*) ¼″ sheets of bituminous or asphalted felt, prepared in rolls and of widths to suit brick walls. Joints are lapped at least 4″.

(*b*) Natural asphalte, heated, and spread upon the wall in ½″ layers.

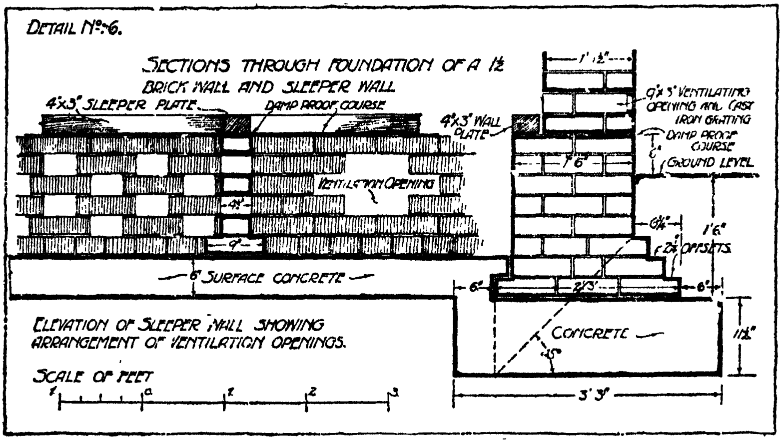
(*c*) Two courses of slates, half lapped at joints and bedded solid in cement mortar.

(*d*) Sheets of 5 lb. lead spread upon the wall, and lapped at the joints in a similar manner to asphalted felt.

(*e*) A combination sheet consisting of lead foil interleaved between two thicknesses of asphalted felt, giving greater durability to the material. "Ledkore" is a good example of this.

We have assumed asphalted felt to be employed in the details illustrated, and treated with pure natural asphalte, not pitch and tar from gas wastes. The "best material only" is worthy of use for damp proofing, as the quantity required for a dwelling is comparatively small and the extra cost is very little over that for low grade material.

21. Workshop walls (back). Detail No. 4 C is a vertical section through the foundation of the back wall to the workshop. It shows the method of constructing the workshop floor, which is of concrete 6″ thick—see page 114—having a ¾″ thick top layer or "floating" of portland cement and sand 1 to 1, and occupies a level of 6″ above the "highest ground level." It therefore coincides with the damp proof course.

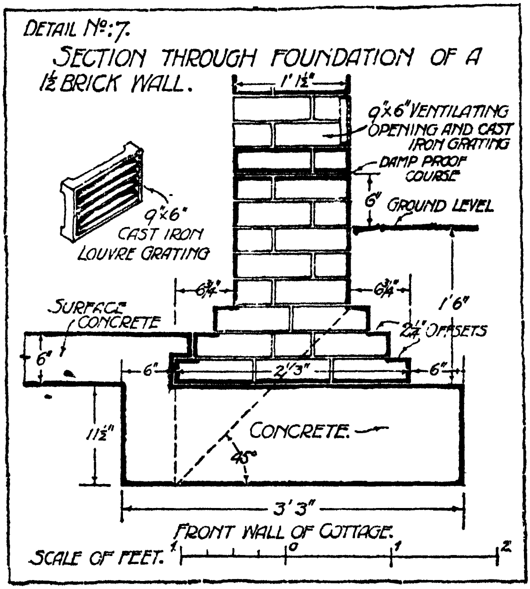


22. Shed wall. A similar section is shown at detail No. 4 D through the back wall of the open shed in the workshop yard. It illustrates the same foundation level, with a different depth of concrete due to a thinner wall, and shows the method of paving the floor of the shed. Its surface is first prepared by excavating the ground to a depth of 9″ below the intended floor level, ramming the earth if necessary to consolidate the surface, laying 6″ of hard dry core such as broken brick or stone in varied sizes, packed close and levelled with engine ashes. Upon this bed, wire cut bricks are laid flat, with mortar joints between the edges.

23. Site covering. The workshop above referred to has a concrete floor which covers the site within the external walls and thus, if of good enough quality, keeps the interior free from damp which might otherwise rise from the ground. To assist in this object a similar broken stone bed should be provided to that described for shed paving and of less thickness—say 4″; 6″ of concrete is

laid directly upon it and the air space between the packed core is efficient in preventing moisture from being transmitted—see detail No. 4 C.

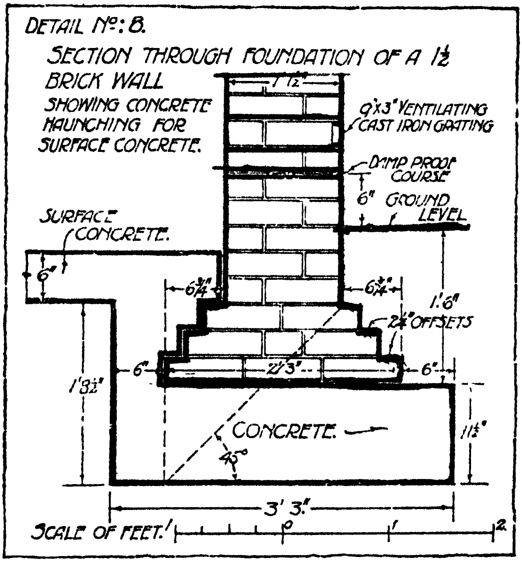
Every domestic building should have a similar site covering, but it would not be convenient to provide it in the form of a concrete floor for many parts of the ground floor of a house. The regular practice in floor construction for dwelling houses is to use wooden bearers and boards in preference to concrete or stone floors, and

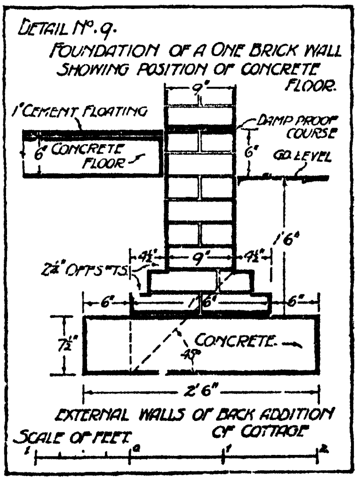


because timber in the presence of damp air is liable to rot, we have a further reason for preventing moisture rising unduly from the ground below the floors. A layer of concrete is therefore placed over the site, within the principal walls, after removing the whole of the top soil, which is seldom more than 12″ deep. Site coverings should be 5″ or 6″ thick, and, if convenient, are best laid as shown in details Nos. 6, 7 and 10 immediately upon the projecting foot of the foundation concrete to the outer walls; thus, by overlapping and connecting with the latter, fissures against the faces of the walls allowing the passage of "ground air" and moisture are avoided.

24. Ventilation of ground floors. It is clear from these details that a space exists between the site concrete and the floor timbers, which, should any damp still rise through the concrete. would become

charged with moisture and affect the timber. To assist further in preventing accumulation of moisture and remove stagnant air,



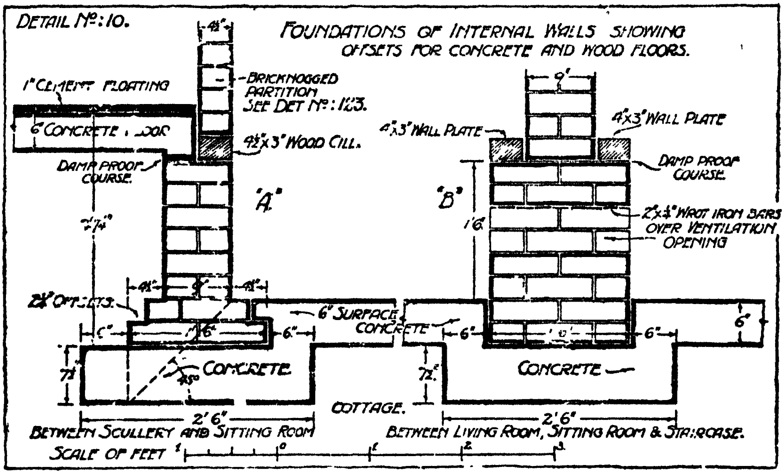


perforated "air inlets" to these spaces are provided as shown at details Nos. 6, 7 and 8. Every enclosed space should be ventilated in this way, so that a current of air is continually passing across and through it.

The best method of ensuring this is to have openings on opposite sides of a building—two, or more if necessary—and to leave openings in every intervening wall for free circulation. Further openings in the adjacent external walls may also be necessary in a larger building. Cast iron gratings and perforated bricks are specially made for this purpose; see detail No. 7 for one good form.

25. Foundation walls and footings. These, while following one general principle in detail of arrangement, as already described, need to be varied in some respects according to their functions and surroundings.

Details Nos. 5, 6 and 10 show in cross section and isometric view the standard construction for the outer walls of the cottage.



In this instance provision is required for supporting the ground floor joists without building them into the wall, and the method selected is to provide a step, called an "offset," on which a horizontal wall plate may be laid to receive the ends of the floor timbers. The provision of an offset where there is no basement should not increase the *base* of the wall beyond what would have been necessary with the joists inserted in the wall—though it does increase the thickness of foundation walling by 4½". Thus, the walls are 13½", the footings 27" at the base and the 4½" offset is placed at the level required for supporting the floor and carried down to join the footings.

Compare sections in details Nos. 6 and 8. The former is through the side walls and the latter through the front wall, and because the front wall receives no joists its section is the simplest possible arrangement. Section on detail No. 6 has the 4½" addition referred to, for supporting the joists.

26. Division walls. Detail No. 10 B illustrates the base of the 9″ division wall between living room or sitting room and the staircase. Its base is 18″ thick making provision for a 4½″ offset on each side to receive the floor joists.

Ventilation openings, 1′ 6″ × 6″, are made through these divisions on each side of the entrance lobby below the doorways to living and sitting rooms.

The brickwork above each opening is carried by four wrought iron bars, 2″ × ¼″ built 4½″ into the brickwork at the sides—see section in detail No. 10 B; also at detail No. 76.

27. Sleeper walls. An examination of the ground floor plan will show the provision for carrying the floor timbers in the boarded rooms. To economise material the floor timbers are of small dimensions, necessitating short spans by providing supports at intermediate positions. The supports consist of 4½″ brick walls resting directly upon the site concrete and enlarged at the base to 9″ wide; such walls may have a few openings provided and of moderate size, but are better "honeycombed" as shown in details Nos. 5 and 6 which give alternate patterns. In both cases it will be seen that bricks are systematically omitted while maintaining enough overlap for support. Perfectly free circulation of air is thus assured. The top course of brick should be filled solid, to receive a damp proof course upon which a wooden sleeper plate is laid for supporting and securing the floor timbers.

Sleeper walls may be bonded to the cross and main walls at their intersections.

Detail No. 10 A is a section of the base of the dividing wall between the sitting room and scullery and is of the type known as a "brick-nogged" partition, having a timber frame filled with brickwork, see page 173. The foundation walling in this case provides a base for the cill of the partition to rest upon.

Observe the position and nature of the scullery floor here, which is of concrete, finished in cement similar to that of the workshop.

CHAPTER THREE

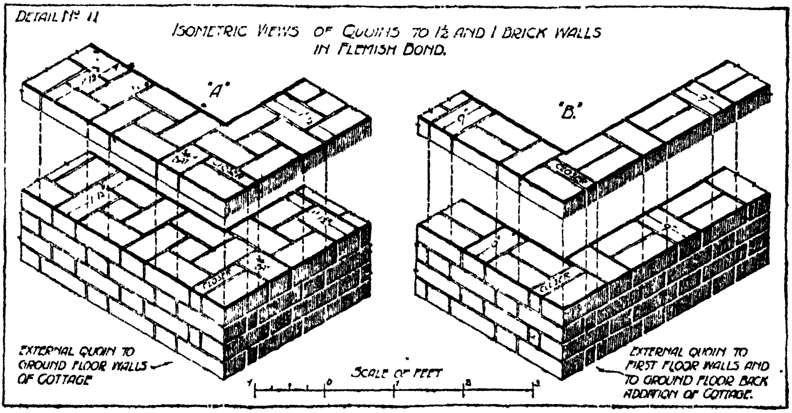
BRICKWORK

General Bonding in External and Internal Walls

28. Having provided the necessary details of the foundations and walls up to the level of the ground floor, we may now study the bonding to the external and internal walls where they intersect each other in plan.

Note. Students must try to understand that the bonding of every part of a wall has some relation to a general scheme of bonding, depending upon the size of the structure and the positions of openings. This is too intricate to consider at the present stage.

29. Quoins. When two walls meet each other at an external angle they form a "quoin," this being the name by which the solid vertical angle of the building is known. The units of brick or stone situated on the angle are termed "quoin bricks" or "quoin stones."

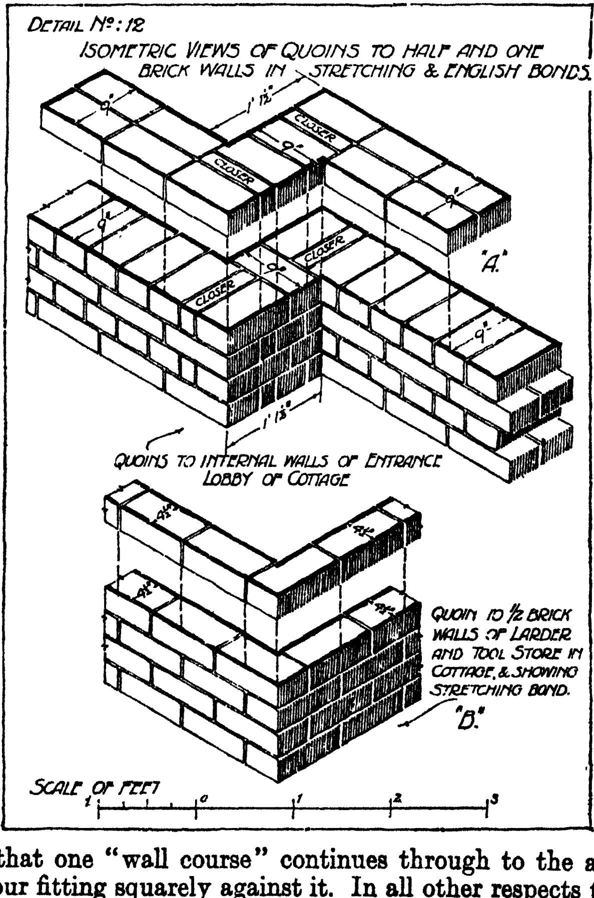


30. Quoins to cottage. Details Nos. 11 and 12 give isometric views of the quoins occurring in the brick walls of the cottage. No. 12 B is the simplest form of quoin, at the intersection of two 4½″ walls (in stretching bond). Its detail is simple and strong—comparatively, it is the strongest obtainable quoin because the minimum lap is 4½″ in each direction from the angle.

Detail No. 11 B illustrates the Flemish bond quoin at the 9″ walls of the back addition and at the upper portion of main building.

Observe that the straight courses of this detail run through alternately to the angle and the "stretching course on one face becomes the heading course on the adjacent face of the same layer."

Detail No. 11 A is the quoin bonding for the $13\frac{1}{2}''$ external walls of the cottage, which are used throughout the first storey. Again



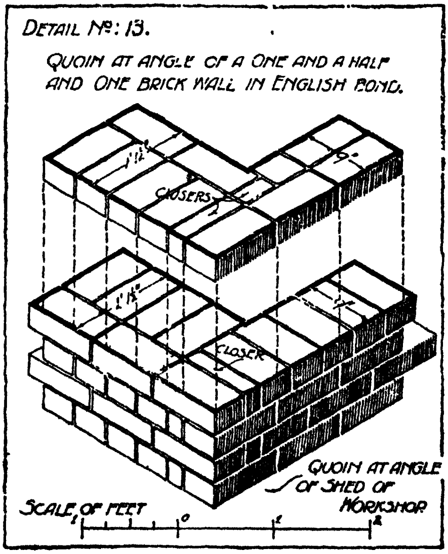
notice that one "wall course" continues through to the angle, its neighbour fitting squarely against it. In all other respects the bond agrees exactly with the earlier examples.

No. 12 A details the bonding for the 9″ internal walls at the quoin of the entrance lobby which is constructed in English bond. The dimensions of the "break" in this wall—which has been made to provide a better entrance lobby—must always be decided by its convenience for bonding, while at the same time giving the desired space.

31. Principles of "quoin bonding." In all the above examples we have accepted and applied a common principle of quoin bonding which, while referred to above, needs emphasising, because it supplies the basis for attacking any similar problem with dimensions varied from those illustrated in our details. This general principle is: *In each course of work, allow the "heading course" side of the quoin to continue to the angle, and make it of the same form as a wall with a stopped end; then let the adjacent side butt square against it while maintaining the correct bond on the face. All such arrangements in right-angled plans, if correct, allow of the reversal of the plan for the alternate course when the walls are of the same thickness.*

Observe also that the three essential measurements of brick bonding are always present at the quoins. On one face the $4\frac{1}{2}''$ header is followed by the $2\frac{1}{4}''$ closer, and on the return face the header shows its stretcher face of 9″. A closer, especially a queen closer, should never be placed at a quoin, but always next to the quoin header.

32. Quoins to workshop. The workshop quoins differ from those of the cottage in having two walls of different thicknesses intersecting; English bond is adopted throughout.

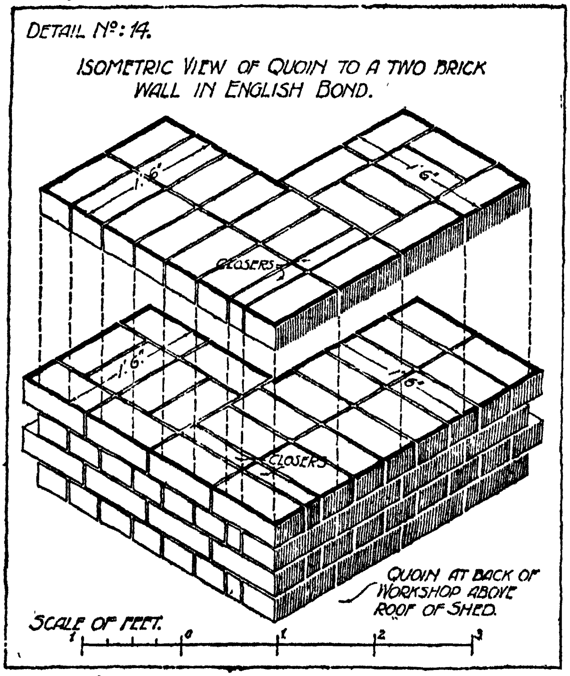


Detail No. 13 represents the quoin at the angle of the shed where a 9″ wall meets a $13\frac{1}{2}''$ wall. This causes a slight "variation" of the above stated principle which always occurs when one of the walls (in English bond) is an odd number of half bricks in thickness. The heading course here may not be carried "completely" through because it would break into the stretching course on the face. It is therefore continued until it meets the "outside stretcher," and the rest is identical with previous details.

Detail No. 14 is the connection of the walls at the back angle of the workshop above the shed roof. Having both walls of the same thickness (18″) and an even number of half bricks, no variation

of application in the principle occurs and the heading course in the "alternate courses" may continue to the angle.

It is now well to observe that in all walls above 4½" thick the quoin bonding on one side ties into the other an effective distance of 2¼" only, and that it is impossible to obtain more lap than this without altering the bond and destroying the cross sectional strength. For all walling except stretching bond this amount is the effective tie.



33. Junctions. When two walls meet each other in such a manner that one wall at least is continuous, the connection between the two is called a "junction." If the walls are both continuous the plan is a "cross," while if only one wall continues the plan is a "tee."

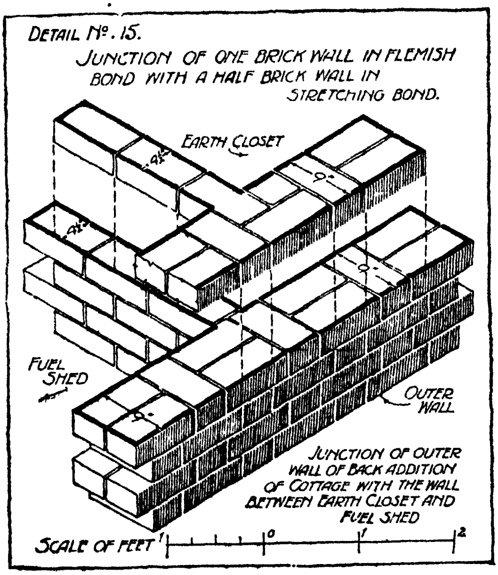
According to the nature of the plan of a building and the need for division into rooms, we may have cross walls of the same thickness intersecting, or walls of varying thickness. In the case of junctions between the internal and external walls thicknesses will usually vary, and the walls may also be built in different bonds.

It is well to observe here that internal walls are generally built in either English or garden wall bond when 9" thick, the former being preferable while the latter is almost exclusively employed in

some parts of the country. Flemish bond, chosen presumably for its appearance, has no advantage for walls which are to be covered with plaster.

34. Junctions in cottage. We have no examples of junctions between ½ brick walls in our plans but these need no explanation if the more common cases are studied which follow immediately.

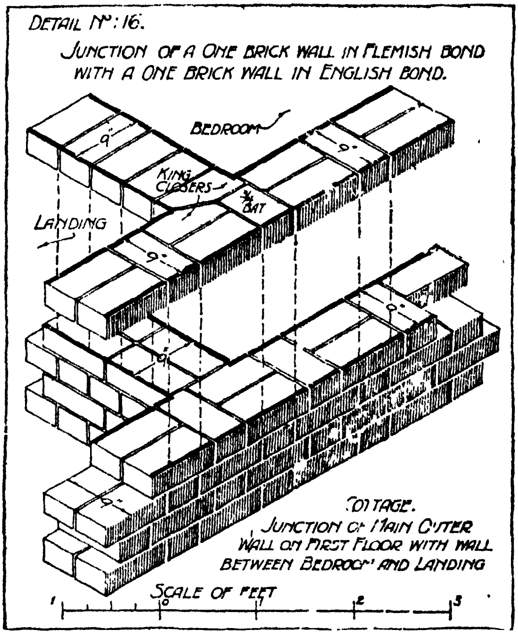
35. Tee junctions. Detail No. 15 is the bond at the junction of a 4½″ partition wall with a 9″ Flemish bond external wall at the back addition. Because the cross wall is in stretching bond we obtain the maximum possible lap of 4½″ as in a quoin between 4½″ walls. The junction is straightforward and economical.

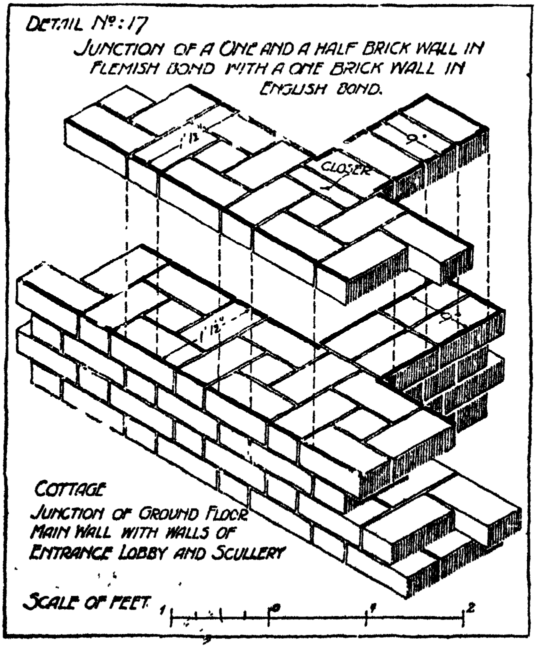


Consider next the junction of the external wall on the first floor, which is 9″ thick and in Flemish bond, with the 9″ division wall between bedroom and staircase, in English bond. In this case, as in all other junctions, the exact detail must vary according to the position in which the two walls meet. If the cross wall in detail No. 17 be moved a quarter or half brick length to the right or left, a different jointing in the bond would result, but we may at least define the method of procedure to determine a satisfactory bond in every case. The "effective bond" in nearly all cases is 2¼″, hence we obtain the necessary lap by allowing every alternate course of the cross wall to enter the main wall 2¼″.

In the detail No. 16 this cannot be done completely without unnecessary and wasteful cutting of the surrounding brickwork, and the most satisfactory bond is obtained by introducing "king closers." It happens that the junction occurs so that one face of the cross wall is opposite a joint of the main wall in one course, and the heading course of the cross wall is made to enter at this point. In the alternate course the two walls are quite detached.

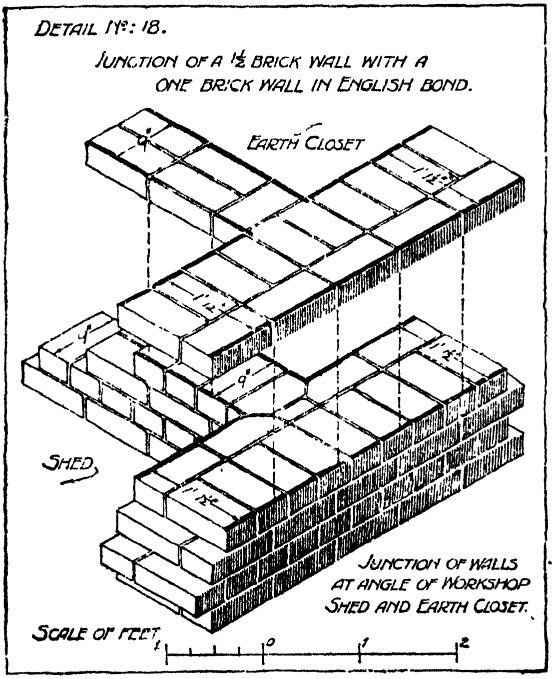
By making the face header into a ¾ bat and cutting the back


DETAIL No: 16.
JUNCTION OF A ONE BRICK WALL IN FLEMISH BOND WITH A ONE BRICK WALL IN ENGLISH BOND.
BEDROOM
KING CLOSERS
¾ BAT
LANDING
COTTAGE.
JUNCTION OF MAIN OUTER WALL ON FIRST FLOOR WITH WALL BETWEEN BEDROOM AND LANDING
SCALE OF FEET


DETAIL No: 17
JUNCTION OF A ONE AND A HALF BRICK WALL IN FLEMISH BOND WITH A ONE BRICK WALL IN ENGLISH BOND.
CLOSER
COTTAGE
JUNCTION OF GROUND FLOOR MAIN WALL WITH WALLS OF ENTRANCE LOBBY AND SCULLERY
SCALE OF FEET

stretcher into a king closer, to meet a similar king closer serving as the starting header in the cross wall, we obtain a good bond with no straight vertical joints.

Detail No. 17 illustrates the junction between a 13½" external wall in Flemish bond and a 9" division wall in English bond. This occurs in two positions in the cottage plan, viz., at the junctions of front wall and cross wall at the entrance lobby and again at the back wall and scullery external wall. As in other examples we have followed the principle of allowing the heading course of the cross wall



DETAIL No: 18.
JUNCTION OF A 1½ BRICK WALL WITH A ONE BRICK WALL IN ENGLISH BOND.

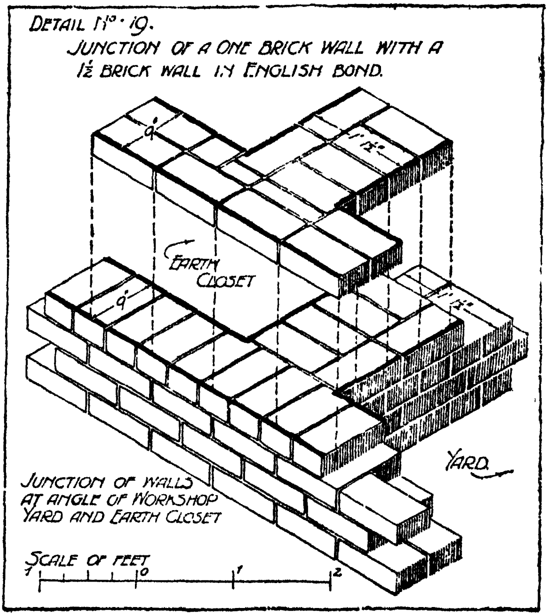
to enter the main wall 2¼" which requires a closer to space it correctly at the commencement; the cross wall conveniently occupies the space which a stretcher would otherwise occupy.

36. Cross junctions. In bonding cross junctions it is usually convenient to allow the alternate courses to appear continuous in plan, the bricks at the junction being placed to secure a tie on each side. Consideration of these cases is left to a later volume.

37. Junctions in workshop. Several examples of junctions occur in the workshop walls, two of which are embodied in details Nos. 18 and 19. They are in English bond.

Detail No. 18 shows the junction occurring between the back enclosure wall to shed and the wall of the earth closet. On first principles the heading course of the cross wall enters the stretching side of the main wall $2\frac{1}{4}''$. Its position demands the use of a closer at the end and two mitred joints at the sides of the entering part.

As an exercise you may usefully sketch the bond when the cross wall is assumed to be $2\frac{1}{4}''$ to the right of its present position.



In detail No. 19 we have a further example where a $13\frac{1}{2}''$ cross wall joins a $9''$ continuous one. One course of the $13\frac{1}{2}''$ wall enters the "stretching course" of the $9''$ wall $2\frac{1}{4}''$, the rest being butted and continuous as before.

38. Rule for bonding junctions. We may now summarise what we have demonstrated to be a usual method of bonding junctions, viz.: *Tie the "heading course" of the "cross wall" $2\frac{1}{4}''$ into the "stretching course" of the "continuous" wall, and make up the consequent spaces in the "regular bond" by closers and bats to avoid vertical straight joints.*

39. Offsets and corbel courses. The two constructive details known as offsets and corbel courses both have for their object the provision of a narrow ledge or shelf on which floor joists or other horizontal members of a structure may be supported.

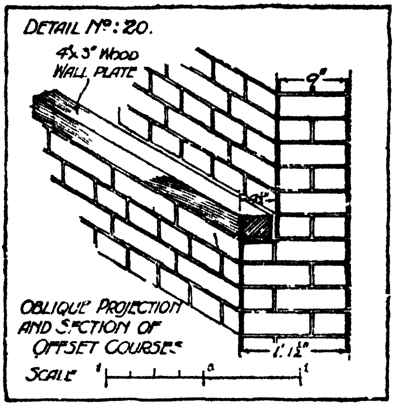
An "offset" is usually a bearing surface formed by reducing the thickness of a wall at some convenient position, 4½″ being the usual width of the "step."

A "corbel" may be either an isolated shelf, or a continuous ledge equivalent to an offset, but constructed by projecting courses of brickwork (or masonry) from the main surface of a wall, such projection being formed in courses oversailing each other in maximum steps of 2¼″. Specially strong corbel courses are formed in 1⅛″ steps.

When required to support floor joists (the most usual purpose) the breadth of offsets and corbel courses need not exceed 4½″.

For the purpose of transmitting a load satisfactorily to the base of a wall an "offset" is much better than a "corbel" because the latter form has a greater tendency to overturn the wall and press more intensely on the base of the wall at the overhanging side.

Detail No. 20 represents the oblique view and cross section of a 4½″ offset in a 13½″ wall, with the latter continued vertically 9″ thick. On the offset is laid a 4″ × 3″ yellow deal wall plate to distribute the pressure uniformly over the brickwork and allow the ends of flooring timbers to be levelled and fixed by notching and spiking, or by cogging, etc., as required (see floor details, page 121).

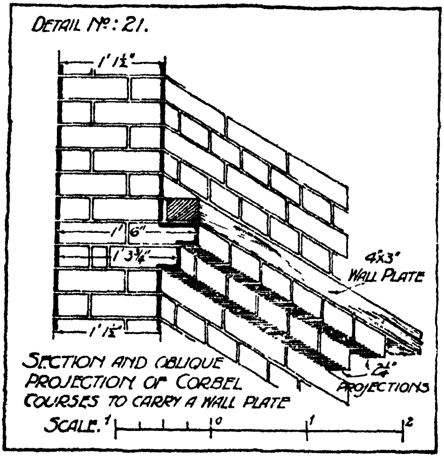


The plate is "bedded" in mortar and levelled, but left clear at the back; this precaution reduces the risk of rotting due to contact with the wet mortar. The only danger is that rain may cause a collection of water behind the plate during the erection of the building. For this reason plates are often treated with "stop rot" or "carbolineum"—applied hot, in two coats at intervals of 24 hours—and then bedded and flushed with mortar at the back joint.

Observe that in the cross section of detail No. 6 the sectional bonding of the wall does not indicate the type of bond employed, which is Flemish, and we may note that no advantage may be gained by making the offset at one course or another; but in English bond, if convenient, the plate is preferably bedded on the heading course for better distribution of the load within the wall, and the tie it affords over a large area. Tall buildings have their walls conveniently reduced in thickness by offsets at floor levels, whether a ledge for the support of floor timbers be required or not.

Detail No. 21 represents the construction of a continuous corbel $4\frac{1}{2}''$ wide formed by projecting two courses of headers over each other in $2\frac{1}{4}''$ steps. The reason for the exclusive use of headers should be fairly obvious because of the strength obtained by "tailing" well into the wall. A continuous row of closers becomes necessary throughout the length of the first course behind the face stretchers.

There is no actual detail of the buildings being studied which embodies this particular application of corbelling to support floor timbers, but we may imagine the external walls being carried from ground floor to roof of the same thickness throughout, *e.g.* $13\frac{1}{2}''$, when it would become convenient to support the floor timbers upon corbel courses.



40. Advantages. The use of offsets and corbels allows the wooden bearers resting upon them to be practically free from contact with the wall and prevents their decay by permitting an air space around them.

In later work it will be found that isolated corbels of brick and stone are required to support single beams and bearers and that continuous corbels are of use in supporting stone slabs, concrete hearths, etc.

41. Piers. A pier is strictly a detached mass giving support to a pair of arches or two girders such as you may see in bridge building where an isolated mass of masonry is placed in mid stream from which arches may spring or upon which steel girders may rest.

The term is more commonly used, however, in a more comprehensive sense and includes all more or less isolated masses of brickwork, masonry and concrete which are intended to provide intermediate support to continuous beams and series of arches, or to increase the stability of a wall by attaching a projecting mass to it immediately beneath a floor girder, roof timber or other structure transmitting heavy loads to the wall.

In order to make our references clear we shall speak of the former kind as "isolated" and the latter as "attached" piers.

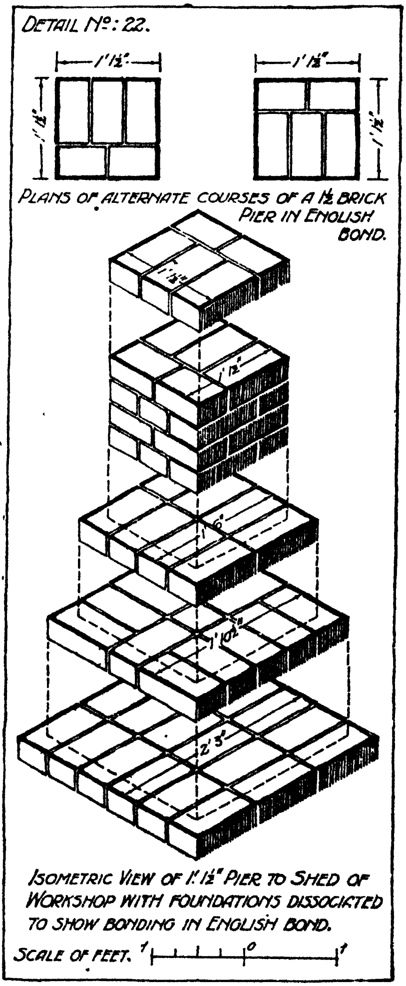
42. Workshop shed. In the shed to the workshop we have an example of an isolated pier, $13\frac{1}{2}''$ square. It may be erected in English or Flemish bond, the latter being the more economical in this size of plan.

The function of the pier is to support the front beam at its centre, thus reducing the span and leaving the shed front sufficiently open for its required purpose.

Details Nos. 22 and 23 explain two methods of bonding this pier and constructing its footings and foundation. No. 22 shows the plans of alternate courses in English bond. The stretchers have to be formed by $\frac{3}{4}$ bats and cause waste, but the bond is good. No. 23 illustrates Flemish bond and is a repetition of the square unit to which your attention was drawn in the detail of a $1\frac{1}{2}$ brick wall—No. 3 B.

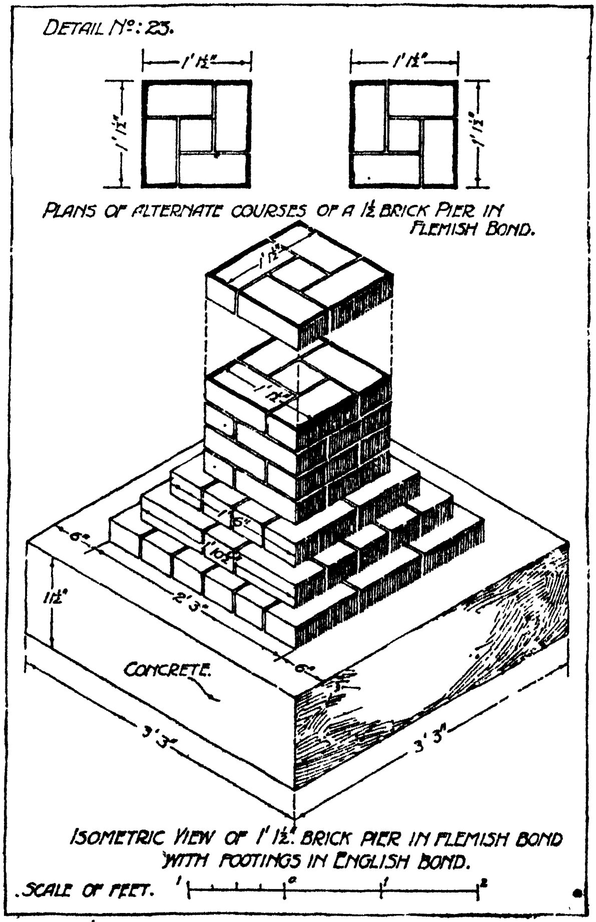
Its deficiency lies in the central square forming straight joints throughout the height of the pier, and for this reason the pier is often built hollow, the $\frac{1}{4}$ bats being omitted. On the other hand the external $4\frac{1}{2}''$ shell is excellently bonded around the pier, the bricks having the "maximum lap" of $4\frac{1}{2}''$.

These details show the bonded courses and also the footings and foundation for this pier, the bases being identical for both bonds. Examine these drawings carefully and you will obtain an introduction to a new application of the principles involved in the bondings of footings.



Now an isolated pier, being comparatively small in both directions, may tend to tilt in "either" direction when loaded, especially if square on plan, and it would not be wise to place the footing courses as headers all in one direction, like those of a wall whose probability

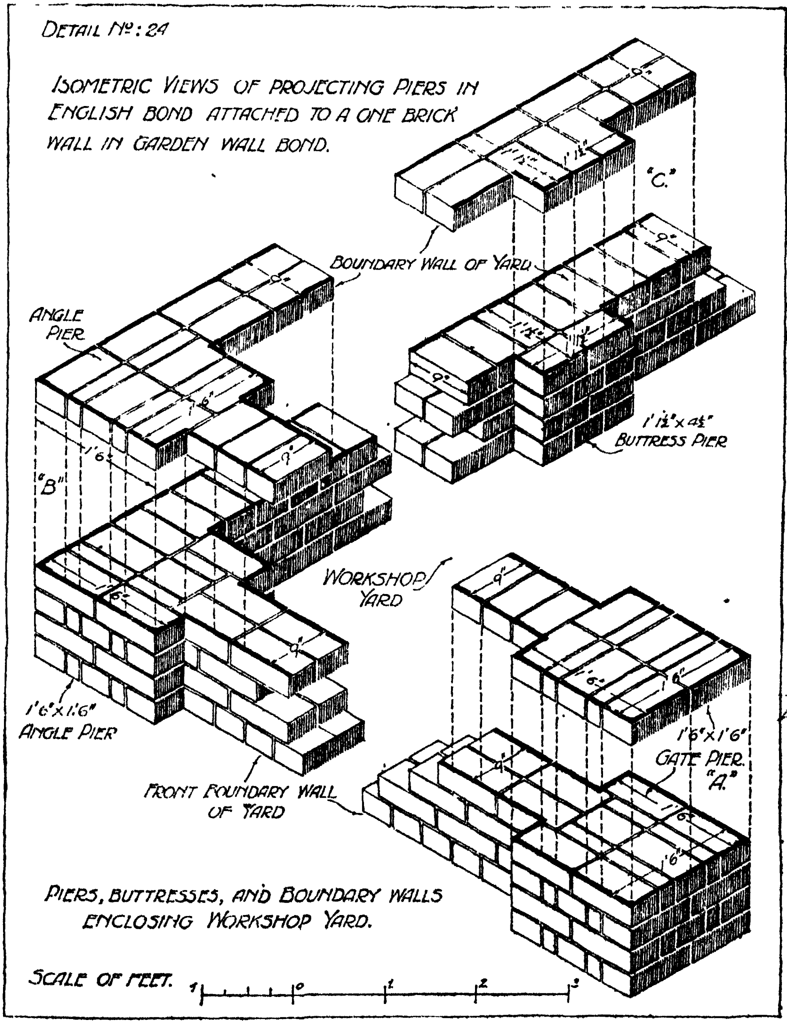
of overturning is across the section transversely. Further, the opportunity for the simplest possible bonding is provided, because the original reason for the introduction of closers is removed, the courses automatically deciding the bond because they reduce in width $2\frac{1}{4}''$ at each edge, thus avoiding the need for closers.



43. Principle of bonding footings to isolated piers. *Lay the footings in English bond, courses of headers alternating in each direction. If in $2\frac{1}{4}''$ offsets no closers are required. Correct bonding involves little or no "cutting."*

The spread of the concrete in square piers is $2T'' + 12''$, as in walls. If the pier is not square the same projection of footings and concrete

is given all round the base, its dimensions being determined from the lesser breadth or diameter.

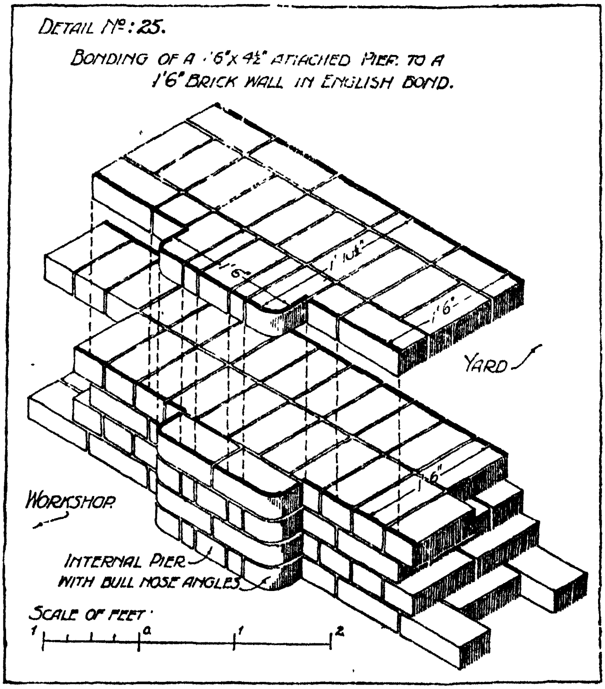


Isolated piers of square plan are easily bonded up to three bricks square either in English or Flemish bond; see Vol. II.

44. Attached piers in workshop. When piers are attached to walls they may be either prominent or subordinate features and we have an example of each kind in the workshop and yard walls.

45. Gate and angle piers. For instance, the entrance gates to the yard are hung to piers bonded to the walls; these piers remain the prominent features at the gateway, because they are thicker and higher than the walls to which they are attached.

At the angle of the yard wall a similar pier to the gate pier is formed to preserve the character of this elevation and give balance to the parts. It does not play so important a part as the gate piers in the elevation, yet it remains prominent, giving strength and boldness to the angle.



Consider the bonding of these piers. In detail No. 24 A the top course of the sketch is the typical bond adopted for an 18″ square pier in English bond, and this arrangement reversed and varied a little will serve as the basis of each course in the gate and angle piers. In this instance we have to preserve the heading course (or stretching course) along the front elevation of wall and pier, and to do this it is necessary to bond the stretching course of the wall 2¼″ into the stretching course of the pier; a ¾ bat along with ¼ closers accomplishes this.

At the angle pier, detail No. 24 B, the same setting is adopted and the heading course of the side wall continued after the first header succeeding the closer, in side elevation.

An "attached" pier of small projection is illustrated at detail

No. 24 C on the boundary wall of the yard. It is a subordinate feature and serves purely as a buttress to assist in stiffening the long length of 9″ boundary wall running parallel to the workshop.

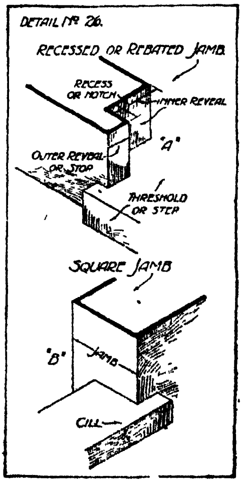
Its projection is $4\frac{1}{2}$″ and breadth on face $13\frac{1}{2}$″, the bonding being secured by placing a pair of $\frac{3}{4}$ bat stretchers against the heading course and bonding these by three headers inserted in the stretching course of the wall. This buttress has an excellent tie, and requires no closers as would be the case if 18″ wide.

46. Attached piers for carrying loads. Detail No. 25 explains the construction of the attached piers added to the interior of the workshop walls immediately underneath the roof timbers which are placed centrally between the windows. These attached piers are used on both back and front walls and their function is to provide a large bearing area for the roof beams and to increase the rigidity of the walls which are pierced by large windows, leaving a pier of brickwork between them 3′ 9″ wide.

The attached piers are 18″ broad by $4\frac{1}{2}$″ projection and illustrate the necessary use of closers referred to previously. As before, the headers of the pier enter $4\frac{1}{2}$″ into the stretching courses of the main wall while the stretchers lie alongside the face. This bond is well suited to "load bearing" piers, because the maximum half brick tie is obtained and the displacement of any bricks, even when imperfectly set in mortar, is improbable.

Such piers as these are often built in better bricks than the surrounding brickwork, thereby adding to their strength.

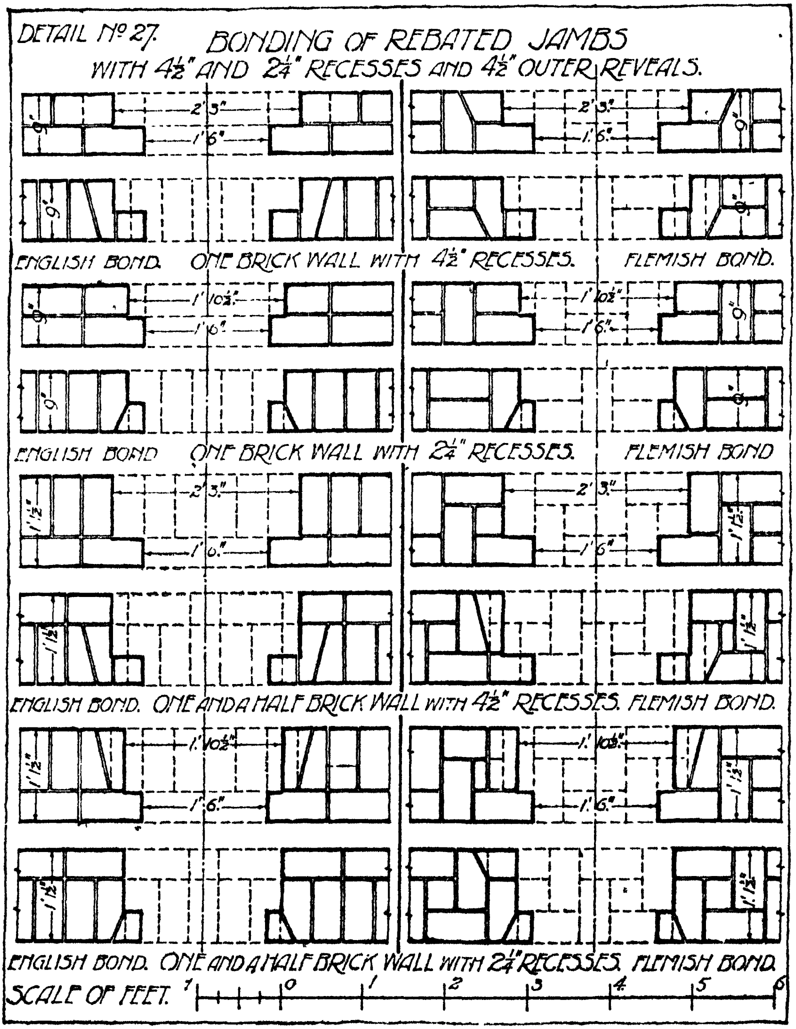
47. Jambs, cills and thresholds. A jamb is the masonry or brickwork immediately surrounding and forming the vertical surfaces at the sides of an opening and therefore occurs in the openings for windows, doorways and fireplaces.



Door and window openings exposed to the weather usually have their jambs constructed with a projecting "stop" on the face edge of the jamb against which the door or window frame may be bedded and secured. The stop—itself often called a jamb—laps over the door or window frame $1\frac{1}{2}$″ to $4\frac{1}{2}$″, enabling weather-tightness to be ensured and draughts guarded against.

The vertical surfaces of the stop are known as "reveals" and the sinking which receives the frame, a "recess" or "notch." Detail No. 26 A. The term "reveal" is correctly applied to all the exposed vertical surface at

the sides of an opening after the door or window frame has been fitted into position; the portion nearest the external face is known as the "outer reveal," while the inner or recessed portion is called the "inner reveal."



Detail No. 26 B illustrates a "plain" or square jamb and provides no recess for the frame. This form is applied at detail No. 130.

48. The bonding of recessed or rebated jambs forms a very important feature in brickwork, and necessitates the use of nearly all

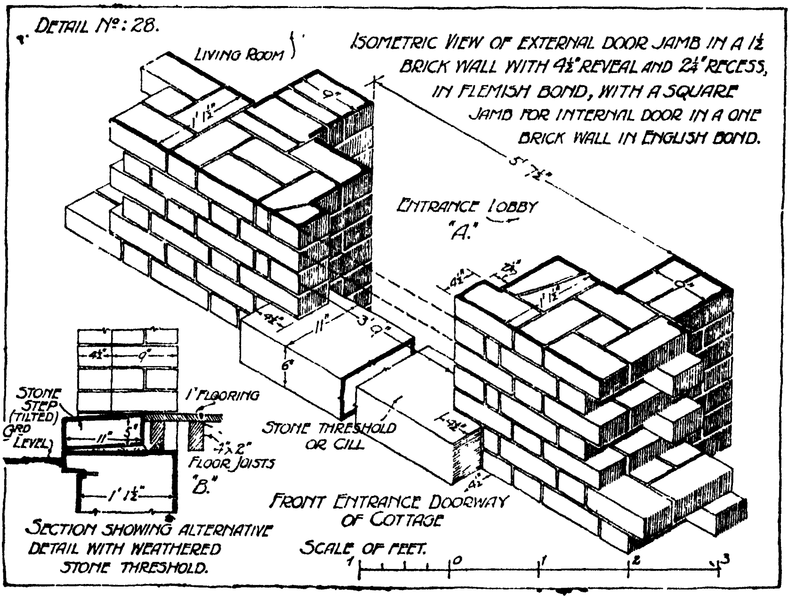
the specially cut bricks, previously illustrated in Detail No. 1. The depth of the recess may be either $4\frac{1}{2}''$ or $2\frac{1}{4}''$, this size depending, to a large extent, upon the type of wooden door or window frame to be used, as will be explained in a later chapter.

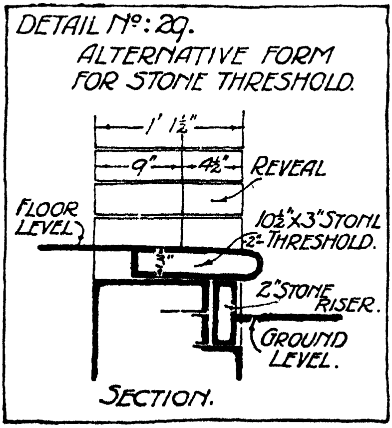
Detail No. 27 illustrates the jamb bonding for a window opening 1′ 6″ wide formed respectively in a "one brick" and "one and a half brick" wall. The jambs are shown with $4\frac{1}{2}''$ and $2\frac{1}{4}''$ recesses, the openings on the left side of the detail are in English bonded walls, and those on the right in Flemish bonded walls. Because the ordinary walling has to be carried through above and below the window opening, this has been shown in dotted lines, in order to indicate its relation to the jamb bonding. It will be noticed that when the width of the window opening correctly coincides with an equal number of bricks, the bonding of each jamb is symmetrical, with the exception of the jambs for the window in the $13\frac{1}{2}''$ wall in Flemish bond, and the student is urged to examine carefully these latter jambs, and ascertain the reasons for their difference. Since all these examples do not occur in the buildings we are studying, we will now consider such variations of them as are required in the door and window openings of these structures. In addition we shall take the opportunity to illustrate the bonding of adjacent parts such as attached piers, square returned quoins, and the provision for, and setting of, brick, stone, and tile cills, and thresholds of brick and stone.

Subsequent details give various sections of these cills and thresholds, but it should be noted that, in building the door or window jambs it is often desirable to provide for the insertion of these features after the surrounding work has been completed, in order to avoid damage, due to vertical settlement at the sides of the opening, caused by the pressure being greater thereon than upon the walling immediately below the cill or threshold. This is particularly the case when cills are of stone, since the unequal settlement will often cause these to crack at the centre.

49. Entrance doorway of cottage. The jamb bonding to the entrance doorway of the cottage is detailed at No. 28. It will be seen that the actual detail of the recessed jambs coincides exactly with the plans of the last example. Our reason for including this detail is the addition of the wing of 9″ wall forming the jambs of the internal doorways leading from the entrance lobby to the living and sitting rooms. These jambs are really equivalent to an attached pier and are bonded into the external wall close to the entrance doorway. The grouped detail at this point is only an application of previous principles. At the foot of this doorway is provided a stone threshold 11″ by 6″, 9″ longer than the opening and built into the brick jambs $4\frac{1}{2}''$ at each end. The purpose of a threshold is to act

as a step, form a base to the doorway, provide for hard wear, and to exclude water. In an unsheltered position stone or concrete must be employed, or very dense brick laid on edge in cement; stone





thresholds are best and may suitably be of hard York stone which is very durable and non-slippery. Stone thresholds 3" thick are often employed formed with a rounded front edge and projecting 1½" or 2" in front of the wall; see detail No. 29.

In stone districts the minimum size of solid thresholds is about 11″ wide by 8″ or 9″ thick.

The method of placing a threshold of any importance in position is to treat it as described for brick cills, viz., complete the brick and stone work for the building, leaving a few jamb bricks loosely laid in sand at the foot of the doorway, then, when the brickwork has sufficiently settled—that is when the mortar is duly set and practically the full load is on the foundation—insert the threshold in position, by removing the loose bricks, bedding solid, making up the jambs by replacing the bricks in mortar, and wedging tight if necessary with pieces of slate. When pointed up neatly we have a satisfactory and durable piece of work.

50. To determine size of threshold. The principle of setting and determining the size of a threshold is to allow the back edge of it to reach the interior face of the door, though the joint is sometimes preferred beneath the door; this generally means 4″ to $4\frac{1}{2}$″ within the recess. The projection in front of the wall outside, is a matter of taste. In this case an 11″ step would project 2″.

51. Fall of threshold. All thresholds have a slight fall outwards to discharge wet from their upper surfaces; $\frac{1}{8}$″ or $\frac{3}{16}$″ in 12″ is generally sufficient at first, and the "wear" on the step gradually increases this; see detail No. 28 B.

Note. Provision for a doormat is often required inside an external door, and in Vol. II will be shown the application of a wooden door cill and a sunk mat-space.

52. Scullery and tool store doorways. Detail No. 30 illustrates the back entrance to scullery and its threshold, the doorway to the tool store alongside it, and the concrete bed serving as a pathway from the scullery door to the back additions. Special care should be given to this detail, as it contains several new features.

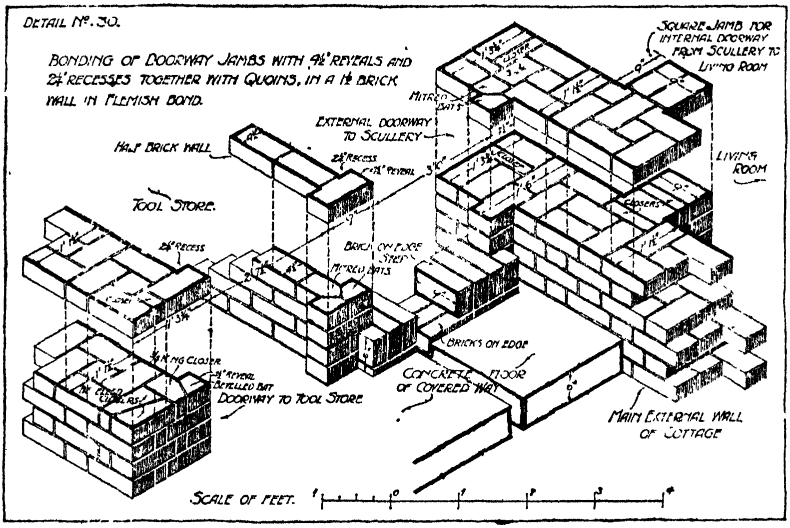
Referring to the back angle of the cottage on the left of the illustration we have a quoin to which is attached a stop for the tool store doorway. Correct "end bond" and "side bond" are to be maintained here, and straight joints are avoided by the use of bevelled closers. The $\frac{3}{4}$ king closer and bevelled bat employed at the tool store reveal should be noted.

53. Tool store and scullery jambs. The division between tool store and scullery requires a recess on each side for the insertion of door frames. The division is a $4\frac{1}{2}$″ wall, and $4\frac{1}{2}$″ reveals with a $2\frac{1}{4}$″ recesses are required. In the stretching course on the face cutting is unnecessary, but the heading course needs two mitred half bats to the front and a mitred three-quarter bat at the end of the $4\frac{1}{2}$″ wall to obtain a tie.

54. Main jamb at scullery doorway. The main jamb at the scullery doorway is quite different in form from any previous case. It is an example of an internal quoin, associated with a recessed door jamb.

Examine the upper course of the wall; its bond is straightforward, containing a closer and full bricks, but its alternate course, shown detached, requires two mitred bats to secure bond.

The attachment of the jamb to the living room doorway (behind, on the right) causes no new difficulty.



55. Brick threshold. Opportunity has been taken here to illustrate the use of bricks to form a threshold.

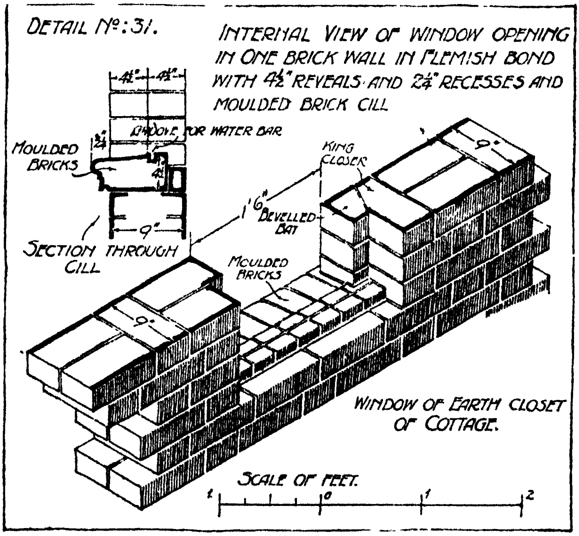
As in the setting of a stone threshold, the wall underneath is brought up to the necessary level to receive it, and bricks on edge with their length at 90° to the wall are laid in cement or good hydraulic mortar.

Threshold bricks should be of a special kind, blue Staffords, hard burnt stocks or plastic engineering bricks being very satisfactory and ensuring reasonable wear and secure foothold. In the event of no special brick being available a careful selection of well burnt, true and sound bricks should be made from the ordinary deliveries.

In preparing for the "threshold setting," observe that the brick on edge breaks the level of the courses, and a stretching course on edge is suitably placed below the threshold bricks so that the two $4\frac{1}{2}''$ deep courses make up three courses of ordinary walling.

Brick thresholds cannot usually overhang the face of the wall if required to reach the inner face of the door (see description for stone thresholds, page 44), but they are often given a small projection, say 1″, and a fall sufficient to eject rain water.

Notice further that the 6″ concrete bed outside the doorway in detail No. 30 is arranged to form a continuous path under cover, and also the floor of the tool shed, without break. It is laid on broken stone and dry engine ashes (see shed and workshop floors, pages 15 and 18) or on a levelled and rammed gravel foundation.



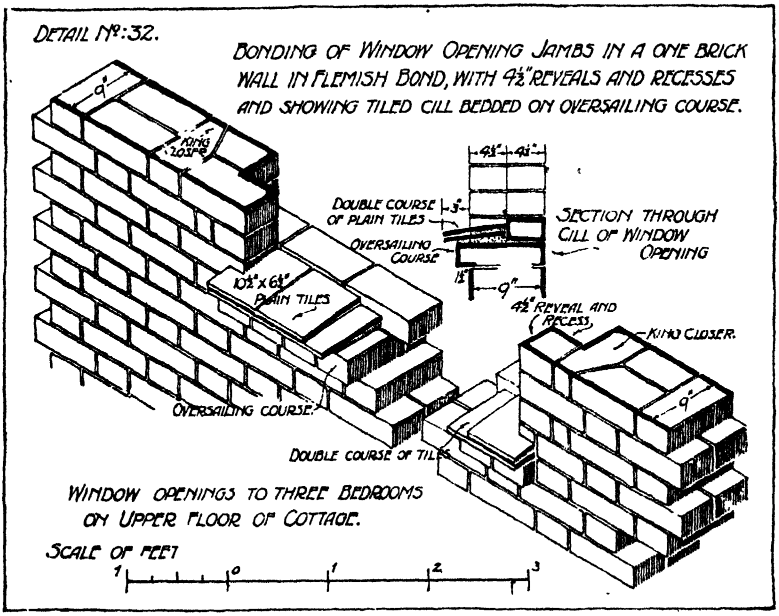
56. Brick cills in single courses. Detail No. 31 illustrates another example of bonding reveals, and at the same time embodies the use of "purpose made" brick cills in single courses.

Single course cills usually consist of purpose made bricks 9″ × 4½″ × 3″ with a weathered and grooved top surface and a moulded and throated front edge; they are placed edgewise, 4½″ deep.

57. Throating. "Throating" is the formation of a sinking in a horizontal surface and is intended to prevent rain water being *driven* beyond it. Rain water, unless intercepted by such a groove, will, in gently falling rain, collect, spread across the projecting surface and trickle down the vertical face of the wall in streams—due to irregularities in the horizontality of the surface—which carry soot and dirt with them and stain the wall. This throating is cut in the underside of cills, copings, string courses, and cornices. In driving rain, "throats" merely prevent the passage of water into joints, when

these are made at the same level, and patches of stain do not occur because the whole face of the wall below the projection is flushed with water; it is trickling water that should be avoided.

58. Setting of cill. Where much weight is to be carried by the jamb walling the cills are advisedly inserted after settlement as previously described at page 41, but in a case like detail No. 31, where the window is formed in a "one storey" building, the cill may always be built in.



59. Earth closet window jambs. The same detail shows how the recessed jambs are bonded, having a 2¼" recess and 4½" reveal in a 9" Flemish bond wall. It entails the use of a ¾ bat at the stretching course and a "king closer" and half "bevelled bat" in the heading course. Observe how the jambs finish in the back view. The fitting and finishing of the window sash will be given in the chapter on Joinery.

60. Cottage window jambs for sliding sashes. In providing for the reception of sliding sashes in cased frames it is customary to form a 4½" deep recess in brickwork and a 3" to 3½" recess in stonework.

Detail No. 32 shows the provision of 4½" recesses for this purpose in the 9" walls on the upper floor of cottage, king closers being necessary to obtain satisfactory bond.

61. Tile cills. The same detail shows a good alternative cill for brick buildings, where "stone" or "purpose made" cills are not available, which may be formed by building a corbel course of brick, $1\frac{1}{2}''$ projection $3''$ below the intended level of the window opening, and making up to the required level by bedding two courses of tiles in cement mortar, half-lapping them at the transverse joints and packing up behind to obtain good "weathering." This is clear from detail section No. 32. Notice that the tile courses project $1\frac{1}{2}''$ beyond the oversailing course and $3''$ in front of the wall.

Plain roofing tiles are used ($10\frac{1}{2}'' \times 6\frac{1}{2}'' \times \frac{1}{2}''$) cut to the required length and placed with the cut edge against the window frame. In some cases the tiles are placed $10\frac{1}{2}''$ lengthwise of the opening to save material, but this is unsatisfactory, because of the curvature in length which is given to all roofing tiles; the curvature should lie across the "width" of the cill and the tiles should tuck underneath the "wood cill" of the window frame and be pointed off neatly in cement or "oil mastic"; see later detail in Joinery, No. 166.

Our example of tile cill is applied to the first floor window openings. It must be understood to present an alternative method, employable if desired, to the whole building.

62. Workshop. Stone cills and recessed jambs. Refer now to the bonding of the recessed jambs to window openings in the back wall of the workshop which, you will recall, is $18''$ thick in English bond. These openings are to be filled with casement windows hung to solid frames and require $2\frac{1}{4}''$ recesses to the jambs. The reveal may be $4\frac{1}{2}''$, or $9''$, as the wall is thick enough to allow the latter, and we have therefore illustrated both sizes, with alternative forms of stone cill inserted; see details Nos. 33 and 34.

We might observe here that stone cills are properly "masonry" work, but, as we cannot dissociate "bonding and the relation of the internal finish" from the stonework here, we have chosen to complete the detail.

Detail No. 33 is a section through an opening illustrating a weathered and moulded stone cill, backed up by an internal brick cill formed of "bull-nose" bricks set on edge in cement mortar, in place of the boarded finish so common to dwelling houses.

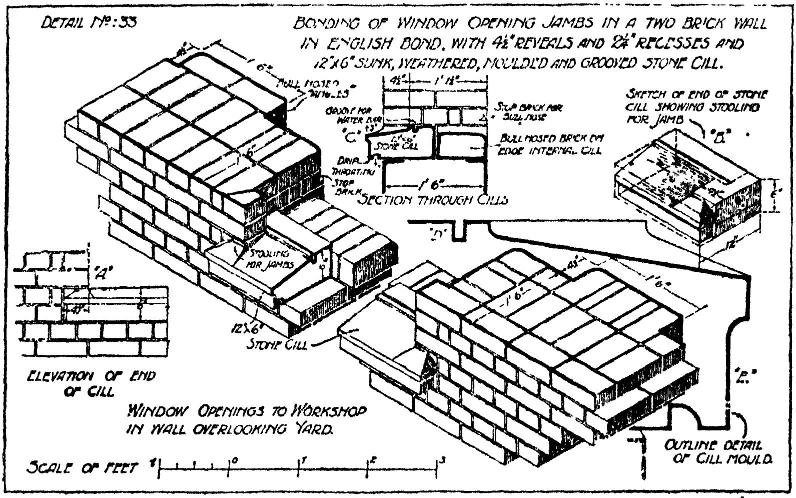
In this instance you will see that the jambs behind the reveal are finished in a similar way with bull-nose angles and that the bonding compares fairly well with a stopped end to an $18''$ wall.

The use of $\frac{3}{4}$ bats and closers behind the stretching course on the right and "king closer" with "bevelled bat" on the left should be specially noted.

"Bull-nose" is a term commonly employed in building to a small quadrant finish, replacing a sharp angle at the intersection of two

plane surfaces, which, if preserved, may be inconvenient or dangerous. Notice that, in our case, to obtain a satisfactory finish at the angle between the internal cill and the jamb, the bull-nose angle to the latter is terminated at the last full course by a "stop brick," upon which the rounded angle is moulded out to a square edge. This enables the cill bricks to be fitted in without introducing any cutting or mitreing at the junction of cill and jamb.

In detail No. 33 the position and bonding of the attached piers have been added to show their relation to the bond of the walling on each side of the opening.



Detail No. 33 A is an elevation of the return "stooled" end of the stone cill and detail No. 33 B an isometric view.

Whether in brick, stone or wood, it is wise to make the following necessary provisions in cill construction.

(*a*) "Weather" or slope the cill on all exposed upper surfaces to avoid retention of any rain water falling upon it.

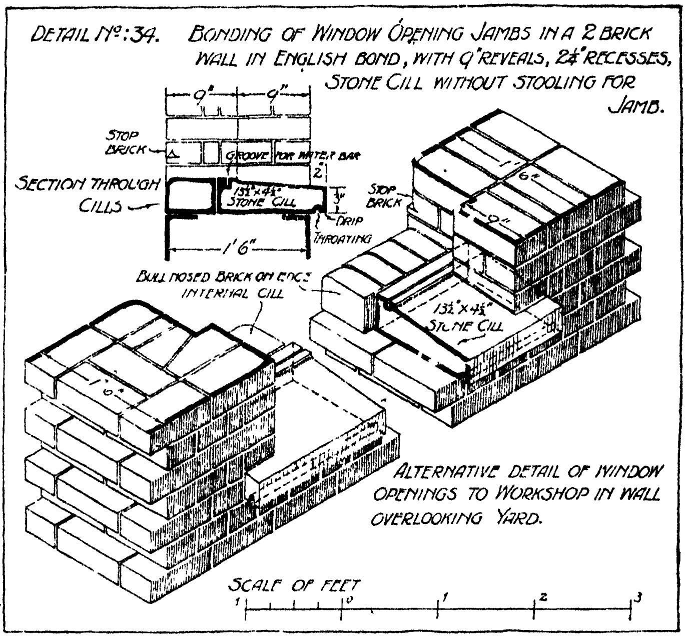
(*b*) Preferably make it project to prevent rain entering any defect in the "bed joint." (Cills which do *not* project require very careful bedding.)

(*c*) Groove any such projection to secure the under surface against rain travelling across it and soaking into the joint, or trickling down the face as described previously in par. 57.

(*d*) Provide some means of "seating" or bedding the wooden cill of the window frame to avoid the entrance of driving rain at the joint. (The common form is to groove the two cills which are in contact and insert a 1″ × ¼″ copper or galvanised iron tongue, called a "water bar." It should be bedded in cement mortar into a ⅜″ wide groove

in the stone cill and in red lead and oil to the wood cill when fitting frame into position.) See detail No. 33 D and also the chapter on Windows.

(*e*) Arrange for dimensions which give proper bonding to the stonework and satisfactory seating for the jamb upon the ends.



63. Moulded cills. Any moulding or other treatment beyond the necessary provisions set out above is either decorative or an extra precaution, and is decided by the personal preference of the designer.

The cill under consideration is 12" × 6" in cross section, thus taking up the depth of two courses of brickwork, and, with a 3" projection bonds 9" into the wall transversely, giving an overlap of 4½" underneath the "window frame cill." This overlap may be reduced to 3" as a minimum which is quite common for stone backings; for brickwork its entry into the wall should be some multiple of 4½".

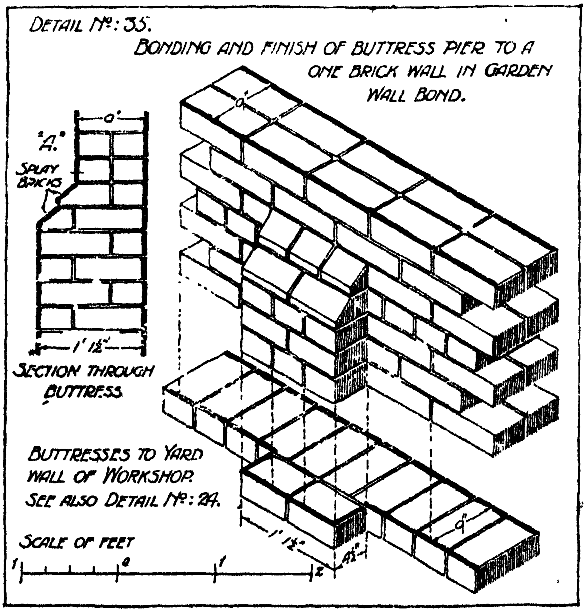
64. Cheaper cills. Detail No. 34 illustrates 9" reveals with 2¼" recesses and a cheaper form of window cill requiring much less material. Its section is 13½" × 4½", the extra width being caused solely by the wider reveal; the weathering is much less than in the former example, being sunk ⅜" or ½" at the recess line, and weathered down to a thickness of 3" at the front edge, giving a bevel of about 1" in 11". Now refer back to detail No. 33 B. A flat bed was provided

here for the brick jamb to seat upon—called a "stool." In detail No. 34 no such seating is provided, the bevel being so flat that bricks may be cut and bedded directly upon it, without fear of sliding. We must make clear, however, that if worked by hand, the stool would always be provided because the labour in the continuous weathering would be greater than that of stooling. Machine worked cills, where the sinking is done by dragging the stone continuously against a fixed tool, are more easily sunk to the ends than stopped. Water bar grooves and throatings should always be "stopped," the former at the depth of the recess beyond the outer reveal, and the latter to correspond at the return end with the true cross section.

Examine the bonding of the reveals and surrounding brickwork attached to this detail, note its features and compare with other examples.

Buttresses, Plinths and Copings

65. Buttress. When any projection is built in attachment to a wall, for the purpose of adding to its capacity to resist overturning, it is called a "buttress" if on the face and exposed, or a "counterfort" when on the inner face and concealed.



"Buttresses" occur in the long boundary wall to the workshop yard, which, because of its great length, is more easily disturbed sidewise.

Buttresses may be treated in two ways:

(*a*) Carried to the full height of the wall to which they are attached and covered over in the same manner by protective blocks.

(*b*) Stopped one or two courses below the top of the main wall and covered in by plinth bricks, or by bevelled courses of ordinary bricks known as "tumbling."

We shall consider the method of covering the projection by plinth bricks only, as being simple and effective, and avoiding cutting.

Plinth bricks are bevelled or "chamfered" on one angle suitably at 45° and $2\frac{1}{4}''$ back from the arris as shown in detail No. 35; at *A* is shown the bonding of the two courses in section. The lower course takes two "$\frac{3}{4}$ bat stretchers," and the upper course three "$\frac{3}{4}$ bat headers" to secure the bond. (Observe that these bricks are made as stretchers—chamfer on a long edge,—and as headers—chamfer on a $4\frac{1}{2}''$ edge.) A little study of this detail will make the surrounding bond clear and illustrate further application of earlier principles.

All "buttress caps" should be set in cement mortar.

66. Plinths. A plinth is a projection near the base of a wall, visible above the ground line, adding to the thickness and stability of the lower part of a structure and continuing downwards to the footings.

It may be a continuous projection—maintained throughout the length of the wall, or may be exclusive to some single feature standing out from the face of the building—for example see detail No. 52, chapter on Masonry, which indicates its suitability for decorative treatment.

For brickwork, the commonest treatment is to make the projection $1\frac{1}{8}''$, $2\frac{1}{4}''$ (or some multiple of $1\frac{1}{8}''$) and of a depth suited to the architectural requirements of the case, the upper courses of the projection being secured against percolation of rain water by continuous courses of chamfered bricks like those used for the buttress of detail No. 35. It is wise to confine the use of chamfered bricks to the $2\frac{1}{4}''$ square chamfer in $2\frac{1}{4}''$ offsets or to $1\frac{1}{8}''$ projections and increasing the number of steps if necessary.

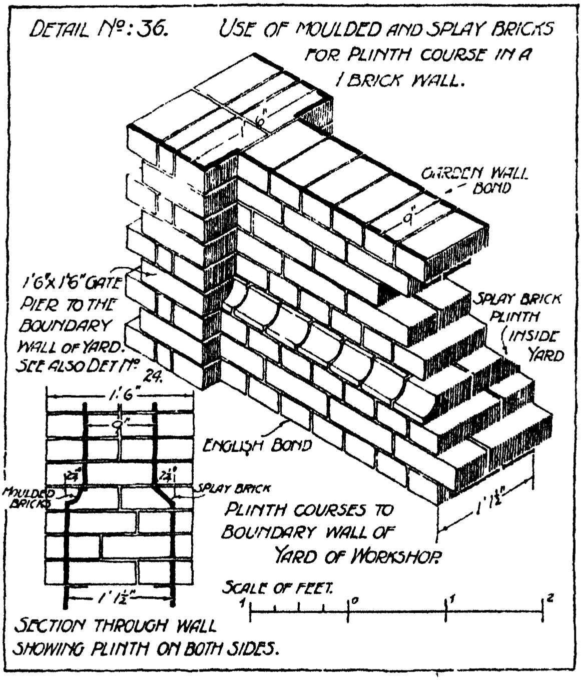
Adhering to the section of detail No. 36 (on the right), we obtain a perfect weathering course.

Plinth courses may also be moulded at the wish of the designer and in brickwork (or masonry) should be of simple outline and contain as little horizontal surface for the retention of rain water as may be suitable to the design.

One of the simplest sections is shown to the left of this detail,

where a "cavetto" plinth course is shown projecting $2\frac{1}{4}''$, having a $1\frac{7}{8}''$ quadrant hollow on the edge.

The principle of laying plinth bricks with a $2\frac{1}{4}''$ projection is to ensure bond by treating the top courses as headers, tailing $6\frac{3}{4}''$ into the wall. With a plinth on one side of the wall only, a course of queen closers is required behind the plinth bricks, running longitudinally with the wall.



Plinth bricks are "purpose made," their external dimensions usually agreeing with those of the same quality and make of "facing bricks." They are not generally cut to obtain bond, but the common brick or plain work to which they are attached is preferably cut to the necessary form and sizes, while adhering to the general principles of bonding.

67. Copings. A coping is a covering to the top of an external wall. Its function is to prevent water from entering the mass of walling through the joints of the top course.

Copings may be of ordinary brick, brick and tiles, special brick or terra-cotta, or stone.

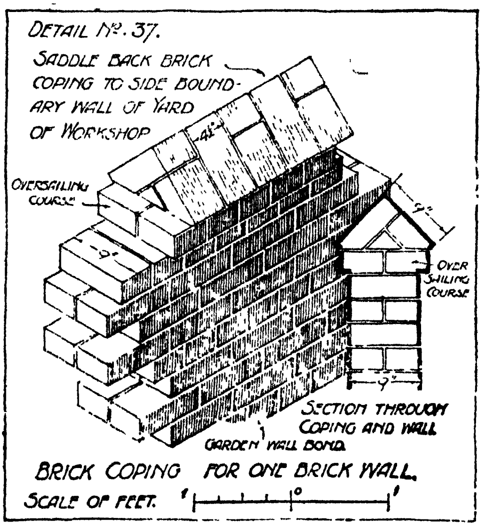
They are named according to their external form as weathered, saddleback, brick on edge, semicircular and moulded.

68. Saddleback coping. Common bricks may very conveniently be made into a saddleback coping of good shape, weathered equally on each side from the centre, by cutting and bonding bricks and setting them in cement mortar as shown in detail No. 37 applied to a 9″ boundary wall.

Immediately before setting the coping, a course of bricks, projecting $1\frac{1}{8}$″, is laid as headers. All these bricks are cut to $5\frac{5}{8}$″ long and laid with the uncut ends showing on the face of the wall.

This course is termed the "coping bed"; it receives the saddleback coping built at a slope of 45°, the inclined courses of bricks being bonded by alternating the full length brick and the bat and set upon the "bed" by constructing a triangular brick core with a right-angled apex, and of the correct size to allow the coping bricks to fit over it neatly and closely, after removing the lower angle of the bricks.

"Oversailing course" is a term also applied to the "coping bed." This and the coping bricks should be set in cement mortar.



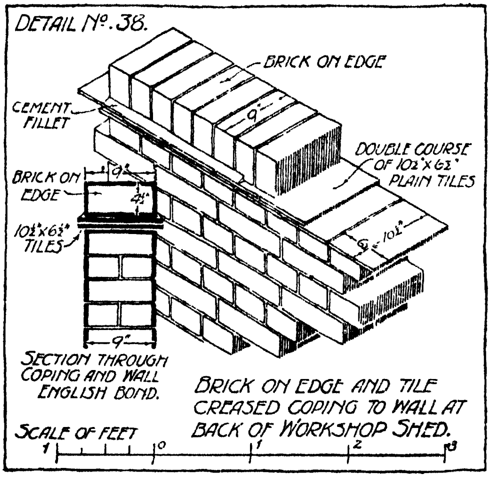
The detail assumes "cover" bricks which have one plain bed at least. Should the bricks to be employed have frogs on both sides they must be set on edge, which will allow of half bats to be employed on the short cover. The core then becomes so small that it is often omitted.

The following process will be wisely followed in setting out the section of the coping:

Place the wall in position about a centre line, draw the top ordinary course and place the oversailing course upon it $11\frac{1}{4}$″ wide; then anywhere above the section place a 45° line from the centre, 9″ long, and drop a perpendicular from the outer end to meet a 45° line from the top edge of the coping bed. This decides the position of the short visible end of the cover brick; place the top edge of the cover parallel to the first sloping line and repeat the form on the other side.

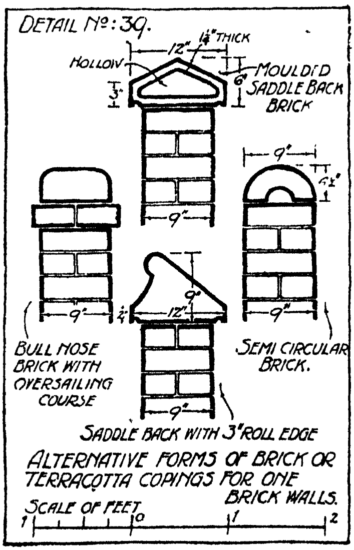
In a well-arranged coping of this type the exposed edge of the cover should be at least 1″ wide.

69. Brick on edge coping. The cheapest possible coping for 9" wall is to set header bricks on edge across the wall as shown in detail No. 38, set and well flushed at every joint in good mortar and without the projecting tile courses.



If laid with a flat top it retains much water in the slight irregularities of surface which eventually finds its way into the joints; these deteriorate and become disturbed. Should the bricks be good enough to warrant it they may advisedly be set in cement and to get rid of water the course canted backwards in order to give sufficient fall without being noticeable.

70. Brick and tile coping. An improvement is often adopted by placing two courses of common roofing tiles $10\frac{1}{2}'' \times 6\frac{1}{2}''$ (or of slates $20'' \times 10''$) half-lapping at the joints and set in cement. Bricks are then laid edgewise as before described and a triangular cement fillet is added to the projecting edges of the tiles, forming a weathering, and clearing off water quickly; see detail No. 38.



In choosing bricks from common stocks for coping purposes, those of good shape, quite sound and with undamaged faces should be selected; if hard burnt, without cracks and glazed slightly in the burning, so much the better for weathering.

71. Special copings. There are many forms of "special brick" and "terra-cotta" coping now available such as "hollow saddleback," "semicircular," "bull-nosed," and innumerable "moulded" forms. We have not applied any of

these in our selected buildings, but give a selection in detail No. 39.

72. Stone copings may be used to cover brick walls, but we have elected to apply them to the purpose of "capping" stone walls. These are treated under the heading of Masonry, Chapter Six.

73. Brick cornice. The workshop wall overlooking the yard is finished with a moulded brick cornice in five courses; there are three plain oversailing courses, the centre one being dentilled by the alternate projection of the headers. These are surmounted by two further courses, the lower one of which is moulded. The total projection of the cornice is $7\frac{1}{2}''$, it is constructed as far as possible in header bricks and provides a seating for the rain water gutter. Details Nos. 104 and 105 embody this feature and give an enlarged profile of the cornice.

CHAPTER FOUR

BRICKWORK

Arches and Lintols

74. When an opening for a door or window has been built to the required height, some method has to be adopted for bridging across it to carry the load of walling, etc., above.

The methods in use are:

(*a*) To bridge it by lintols of wood, stone, metal or concrete.

(*b*) To unite several bricks or comparatively small stones at vertical surfaces, while maintaining a level "soffit," or under surface, forming what is known as a joggled lintol.

(*c*) To construct a support of bricks or stones in the form of an arch.

(*d*) Such combinations of the above forms as may be convenient for the case.

75. Lintols are horizontal pieces of stone, wood, metal or concrete spanning an opening in a wall—such as a doorway or window opening —the function of which is to support the walling continued immediately over it.

In the ordinary meaning of the term the lintol is in one length across the width of the opening, though two or more pieces may be laid side by side to make up breadth equal to the thickness of the wall.

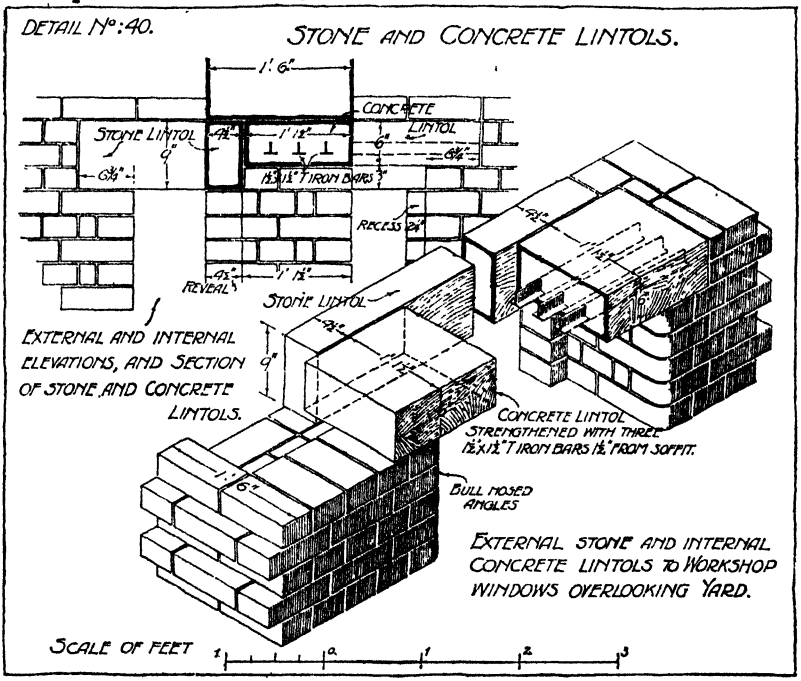
In brickwork stone lintols are often employed on the face side of the wall backed up by a wood lintol where the interior is to be plastered, but where desired, an inner stone lintol may be adopted, or a rolled steel section, or, again, a concrete lintol.

Where the outer reveals are $4\frac{1}{2}''$ wide, stone lintols for the external face are usually $9''$ deep $\times$ $4\frac{1}{2}''$ thick, set on edge; $3'\ 9''$ should be the maximum span for these without either an intermediate support, or some method of relieving the lintol of load. Wood lintols, of $3''$ stuff laid flat, make up the remainder of the width and are lifted $3''$ to a higher level, thus providing a recess for inserting the window or door frame.

In detail No. 40 of workshop windows overlooking the yard we have shown the setting and dimensions of a stone lintol, with $6\frac{3}{4}''$ bearings, and the bonded jamb on which it rests. We may safely adopt a minimum bearing of $4\frac{1}{2}''$ for spans up to $3'$, and $6\frac{3}{4}''$ bearings for larger spans up to the limit stated above.

The same detail shows an alternative to the wood lintol previously referred to and consists of a $13\frac{1}{2}'' \times 6''$ concrete lintol strengthened or "reinforced" near the lower surface with three "tee-iron" bars, $1\frac{1}{2}'' \times 1\frac{1}{2}'' \times \frac{1}{4}''$ thick.

Half-inch diameter round steel rods—four or five in number—or a similar number of strands of galvanised barbed wire may also be employed for the same purpose, thus preventing the concrete from fracture by vibration of the structure. Detail No. 56 shows this application, which is peculiarly suited to the workshop where the brickwork is to be left exposed on the interior.



In the north of England stone lintols are commonly known as "stone heads" or, when applied to windows and doorways, as "window heads" and "door heads."

The business of the bricklayer in connection with lintols is to set them in correct bond and see that they are of suitable dimensions to embody in the work without break in the bond or unsightly continuous vertical joints.

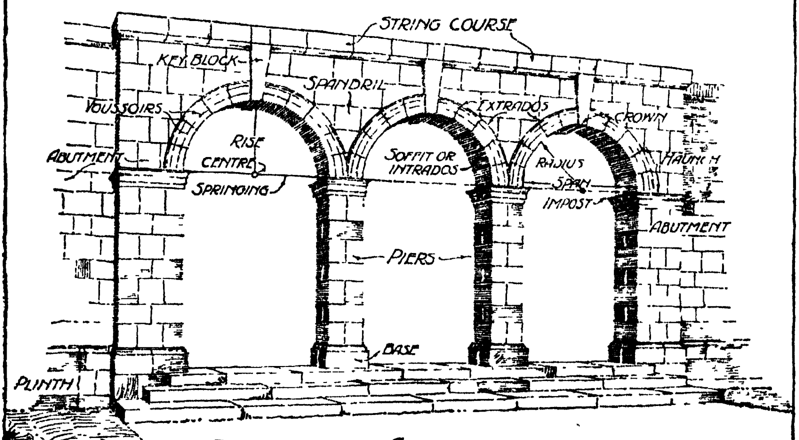
76. Wood lintols. The use of the wood lintol varies in different parts of the country. In some cases the practice is to increase the dimensions of a wood lintol to meet its intended load, allowing it

to support the walling without assistance, while in others the lintol is employed to bridge the opening temporarily, or to serve for fixing purposes, and all load from walling relieved from it by erecting an arch above it. We shall discuss this later in connection with relieving arches.

77. Built up or joggled lintols. These are built by uniting vertical surfaces of bricks or stones by some joint which prevents one unit slipping away from another.

78. Arches. A true arch is an assemblage of comparatively small units of material, whose complete outline, combined with the shape of its units, renders it largely self-supporting. To attain this end the units are always wedge shaped, so that, when the whole structure is loaded, the wedges tighten against each other and afford mutual support.

DETAIL No:41.



SKETCH OF AN ARCADE IN STONE, GIVING TERMS USED IN CONNECTION WITH ARCHES.

Every arch maintains its position by having sufficient opposition to its "thrust" to resist outward movement of its supports, the thrust being caused by the pressure of the several wedges against their neighbours.

Before entering into the variations of "arch outline" we shall study the simple and well-known semicircular arch and learn the names of all the "parts of an arch" and of its associated "supports and decorations."

Detail No. 41 is a perspective sketch of a "series of arches," called an "arcade," and although it is not related to our buildings we have

selected it in order to define and illustrate fully the terms used in connection with arches and their contiguous parts.

In the arch as a *structure* we have:

Voussoir or *Arch block*, any wedge shaped piece of material forming a "unit" of the arch.

Key or *Key block*, the voussoir at the immediate centre of the arch, which is the last block laid and "keys" or "locks" the other voussoirs in position.

It is often larger and heavier than the other units and affords scope for decorative treatment.

Crown, the highest part of the internal curve of the arch outline.

Extrados, the "outside curve" of the ring of voussoirs.

Intrados, the "inner curve" of the arch ring.

Soffit, the under or "inner surface" of the arch—seen from below.

Centre, the centre of curvature in a "circular" arch. The elevation of the axis of the cylinder "of which the arch forms a part."

Radius, the radius of curvature of the "intrados" curve. Applies "strictly" to circular arches only.

Springing line, the line, generally horizontal, from which the lowest point of the arch springs at the intrados. The "*chord* of the arc of curvature."

Span, the clear horizontal distance between the supports.

Rise, the perpendicular height from springing line to crown.

Haunch, the intermediate portion of the arch ring between the springing surface and crown.

Bed joints, the joints between the voussoirs at right angles to the face of the arch. Each bed joint should be normal (square to the tangent) at the point on the curve through which it passes.

An *Arch course* lies "lengthwise" of the arch, viz. at 90° to the face, each face voussoir being the end block of a course. Thus, bed joints may also be defined as the "joints between the courses."

The *Length* of an arch is the horizontal distance between its two faces, and the "face" is generally the surface seen in elevation, showing the true form of the arch curves.

The *Depth* of an arch (or thickness) is the distance across the face of the voussoirs measured "normally" between the curves. In circular arches every radius is normal.

79. Arch supports. *Abutment*, the mass of brickwork or masonry supporting the arch on each side. That on which the arch abuts, or from which the arch springs.

Pier, a comparatively narrow abutment between two arches. The two arches spring from this common support, sometimes partially intersecting over it.

Skewback, the surface of the abutment on which the arch rests and from which it derives support. The first joint which is normal to the curve.

Base, an enlarged support at the bottom of a pier—often moulded. Similar in character to a plinth so far as appearance is concerned; but the base is the "solid mass" on which the pier rests.

80. Contiguous parts. *Arcade*, the series of arches divided by piers as shown by detail No. 41, supporting a continuous wall. The piers are often circular and are then called "columns."

Spandril, the curved triangle of walling dividing the arches where they adjoin on the top of a pier.

Impost, a moulding placed at the springing of an arch to emphasise the line, and to give "weight" and "appearance of strength" to the abutment.

String course, a continuous projection from a wall, plain or moulded, serving a decorative purpose in providing a line or band of division between two parts of a frontage. A "string" is illustrated above the arcade in detail No. 41.

The impost moulding is often continued horizontally along the plain walling on either side of an arch. It is then called a "string course."

Plinth, or base mould. A projection at the base of a wall. Serves to add strength and rigidity and is decorative in addition.

81. Forms or shapes of arch. Arches are named according to their shape and, in our two structures three forms are employed, viz.:

(*a*) Semicircular.

(*b*) Segmental,—being an arc of a circle less than the semicircle.

(*c*) Flat or camber; this type has a flat extrados, but the intrados is seldom quite horizontal, usually being raised at the centre by making the soffit a very flat segment. Such a small rise is called "cambering." (For reason see detailed description, page 65.)

Arches are further classified according to the nature and finish of the labour bestowed upon their construction, and also by the use for which they are intended.

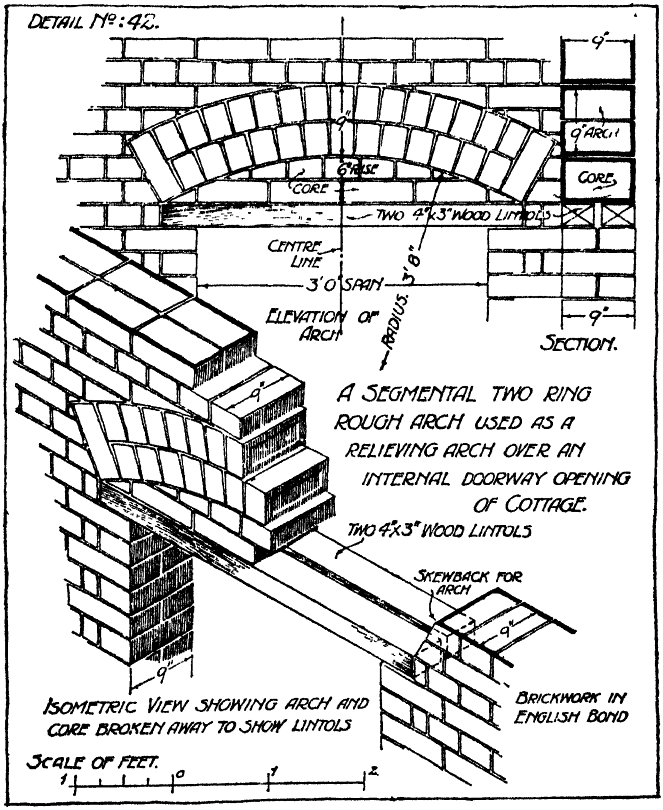
82. Classification of arches. There are three general varieties of arch, differing considerably in appearance, viz.:

Rough arches, rough-cut or axed arches, and gauged arches.

83. Rough arch. A rough arch can scarcely be termed a "true" arch for it has its voussoirs composed of ordinary bricks with parallel beds. When each of these is set with its centre line radial to the curve, and the space between the bricks filled with hard-setting mortar which adheres to the brick, it does however make a reliable structure. Bricks with a frog to each bed are wisely chosen for such an arch

(detail No. 42) and the soffit edges of the bed joints should be brought almost close together.

Key is thus obtained by the wedge shaped mortar fillings. Rough arches—of sufficient depth—set in hydraulic or cement mortar are quite reliable and in any case such arches, well built and adequately supported until set, have been constantly employed to carry heavy



A SEGMENTAL TWO RING ROUGH ARCH USED AS A RELIEVING ARCH OVER AN INTERNAL DOORWAY OPENING OF COTTAGE.

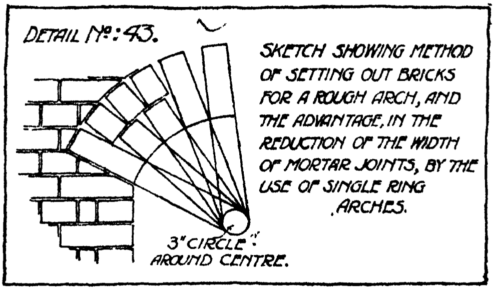
loads across large spans. It is, of course, easy to see that, comparatively, the arch is most deficient at the joints in short spans and sharp curvatures.

Rough arches should be built in half-brick rings ($4\frac{1}{2}''$ deep). This enables us to avoid the very thick joints which would occur at the extrados if 9″ deep rings were employed; $4\frac{1}{2}''$ rings also allow us to bond the arch very thoroughly in the direction of its length, each ring being in stretching bond like a half-brick wall. The depth may also be added to as desired, by increasing the number of rings.

The only exception we shall make is in starting the arch by placing "arch headers" at the skewbacks in order to tie the abutment courses and distribute the thrust effectually.

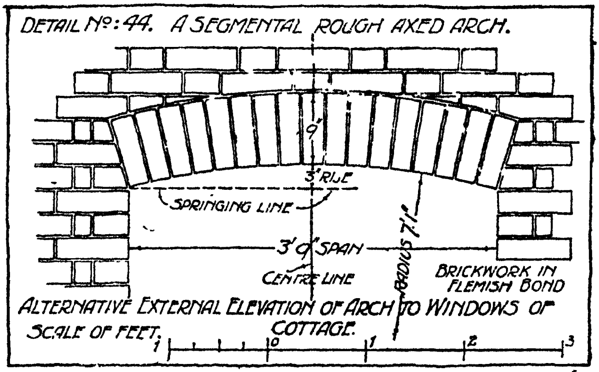
Note. Rough arches should always have a medium curvature and are most suited to segmental arches or semicircles of large span.

84. Use of rough arches. Because rough arches are cheap, and yet quite satisfactory for performing the work they are called upon to do in an average building, they are almost invariably employed for all purposes where arches are necessary but hidden from view by plastering the wall surface.



They have *other* uses where they are both visible and prominent but these we shall omit from our present consideration.

85. Rough-cut or **axed** arches are those in which the brick voussoirs are prepared from common bricks, by cutting more or less roughly to wedge shape with the bricklayer's axe. The joints



are somewhat irregular and thick, similar to ordinary brickwork—see detail No. 44. These arches are strong and useful if set in good mortar, and they may be axed in half-brick rings or to bond on the face as shown in the illustrations of gauged work.

86. Gauged arches. In this class of arch the brick voussoirs are accurately prepared to the bevel required, resulting, when neatly set, in fine straight joints $\frac{1}{32}''$ to $\frac{1}{16}''$ in thickness.

The term "gauged" means accurately "measured," and arose through the method of preparing, by hand, arch voussoirs from specially chosen rectangular bricks which conveniently cut and rub to shape.

Gauged work is the highest class of brickwork in architectural use, and is built from special bricks, burnt just hard enough to allow of their easy reduction in size and shape for their intended purpose. (Apart from arches we shall deal with gauged work in a later volume.) Examples of gauged arches are shown in details Nos. 45, 46 and 47, which also illustrate the three shapes of arches previously mentioned.

87. Purpose made bricks for arches, etc. Before entering on the detailed description of these arches we must note that modern machine made "pressed brick" is largely replacing gauged work, for it can be produced in blocks varying little in shape and of any required forms to special order. Further, as brick arches are largely standardised in form and span, it is often easy to meet one's requirements from manufacturers' stocks. Flat and cambered arch voussoirs for spans up to 3′ are obtainable "in series" quite easily, and are employed largely in cottage building.

The objection to these bricks is their crude colour and lack of all artistic quality. For durability they are first-class material.

Efforts are now being made however to produce durable bricks of higher artistic merit, while meeting the needs of both ordinary and special work.

The degree of success attained may be gauged by the photographic details in the earlier part of this volume. The frontispiece and details Nos. 2, A to E have been kindly supplied by well-known brick manufacturers.

The former shows how special texture brick having a "rustic" surface may be modelled in clay, divided into blocks for coursing and bonding, then burnt and afterwards erected like ordinary brickwork.

Any special form of brick may be obtained in the same material.

The panel illustrated was designed for insertion above the flat arch of the workshop entrance—see general illustration—and, with proper setting, would provide a durable and artistic piece of brickwork.

Detail No. 2 illustrates the ordinary use of texture bricks having a sufficient variation in colour and absence of vitrified surface to avoid the hard, crude appearance of the bricks so commonly employed in some districts.

Both the above examples show excellent materials for architectural use in suitable surroundings and should be remembered in later work when materials are being specially considered.

88. Rough relieving arches. Refer to detail No. 42 which shows the application of rough ring arches for the purpose of relieving wood lintols of much of their load. We have previously referred to wood lintols as being convenient for securing woodwork, and especially is this so in attaching wooden finishings to window and door heads internally.

The name "relieving" arch is distinctive, and has nothing to do with the "shape" of the arch or the kind of labour bestowed upon it. It merely refers to the "use" of the arch in relieving a subordinate feature in the same structure of responsibility for load.

In brickwork the relieving arch is commonly of "segmental outline" and of two "rough rings" in construction. The details show the method of construction—in elevation and isometric view—for a 3′ door opening to the sitting room of the cottage. The wall is 9″ thick and two wood lintols, 4″ × 3″, are laid flat in one course with a 1″ space between them and bearing 4½″ upon the walls. Observe that an arch, to relieve these lintols of weight, must have its abutments "clear" of the lintol, hence the abutments are splayed outwards and upwards from the ends of the lintol. In this case we have adopted a "rise" of 6″ and a "depth" of two half-brick rings, and the top edge of the lintol is the springing line.

Set out the arch by placing opening and wood lintol in position about a centre line, measure the rise above the lintol, then by the geometrical problem for determining an arc to pass through three points (ends of springing line and crown) draw the intrados curve; see also detail No. 45 where the same problem is illustrated and applied.

Place two arcs 4½″ apart parallel to the first curve terminating upon radials through the springing points. We have now the "arch outlines."

Insert the two header bricks at the skewbacks with their centre lines radiating from the centre of curvature; then, divide the inner arc into an odd number of parts, if possible 3″ apart. It may be necessary to reduce this size in the drawing in order to obtain the odd number and keep within the maximum width of 3″, allowing joint. In practice the arch would be built with the bricks laid against each other as closely as possible at the intrados, and adjustment made near the crown by cutting a few bricks.

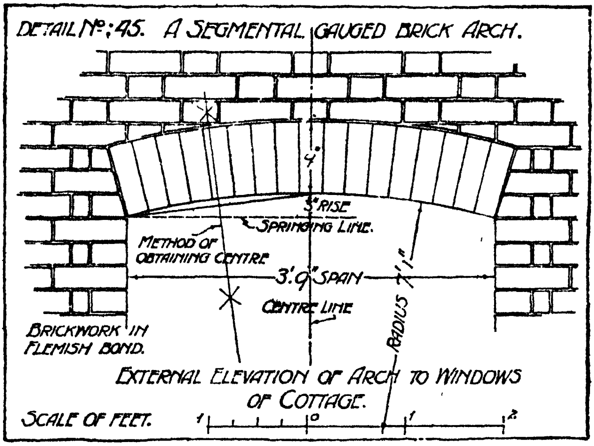
Continuing the drawing: To obtain the beds of the voussoirs parallel to a centre radial across the face of the brick, proceed as follows, referring to detail No. 43:

About the centre of the arch describe a circle 3″ in diameter. Step off the thickness of brick courses on the intrados of the ring, and place a straight-edge to pass through a "joint division" on the intrados and tangential to the 3″ circle. Do this on both sides

of the circle for every joint, so that you have, across the arch ring, a short length of two tangents to the circle forming a small wedge. Satisfy yourself that every brick represented has parallel edges and therefore its centre line is radial, passing through the centre of the arch.

Repeat the process for the outer ring, observing that the middle arc is its soffit curve.

The method of building the rough arch is to provide a means of support having the necessary soffit curve (see Centering), cut the skewbacks to the correct slope, set and bed the starting headers so that the under edges are as nearly tangential to the curve as the bricklayer can place them by sight, then add the half-brick rings (arch stretchers) by building up from each skewback towards the



crown, over-flushing each joint with mortar and tapping down to the desired position.

On nearing the crown the joints must be adjusted by cutting, if necessary, in order to secure the central position of the "key," which is preferably a full size brick.

Because the two rings are quite separate structures between the skewbacks, their bed joints do not coincide. Do not attempt to make them do so, but pack the bricks close at the intrados curve for *each* ring.

In some districts it is common practice to build the segmental brick "core" between the arch and lintol first, cutting it roughly to fit a "reverse templet" (pattern) of wood whose shape is that of the soffit curve. By flushing joints and inaccuracies with mortar a fairly well-shaped core is obtained and the arch is then laid, upon the core as a support, in the manner described above. Such an arch

does not truly relieve the lintol of weight, because the load has to depress the lintol before the arch transmits any thrust; it would, of course, act as a safeguard against over-depression and prevent failure. Further, if the wood lintol has been inserted in a wet (unseasoned) condition and subsequently shrinks much, the arch may at once become active by the settlement due to shrinkage.

The correct method of building all arches is to support them during construction by temporary supports called "centers" (see Carpentry); when complete, the supports are "slightly withdrawn" to allow the joints to compress, and the arch takes its final position and is allowed to "set." In building operations of the dimensions we are considering, addition of walling and load is proceeded with at once, care being taken to let the weight accumulate uniformly across the span.

Referring now to the relieving arch of our example, detail No. 42, note that the core is filled by cutting and fitting from each face, after the arch is fully loaded and the centering removed. For the methods of supporting this segmental relieving arch, see detail No. 68.

89. Advantage of "relieving" arches. The advantages of relieving arches over doorways and window openings where wood lintols are employed may be summarised thus:

(*a*) Guard against undue settlement, either primary or subsequent, which may become considerable for spans over 3′ where loads from floor beams or partitions are necessarily transmitted to the wall above them.

(*b*) Decay of the wood lintol would cause no structural damage at the opening, but would only affect any wood finishings to the same.

90. Cottage window openings. The larger windows of the cottage are 3′ 9″ clear span and the openings, externally, are supported by gauged (or by purpose made) arches of segmental outline, with a 3″ rise. Detail No. 45.

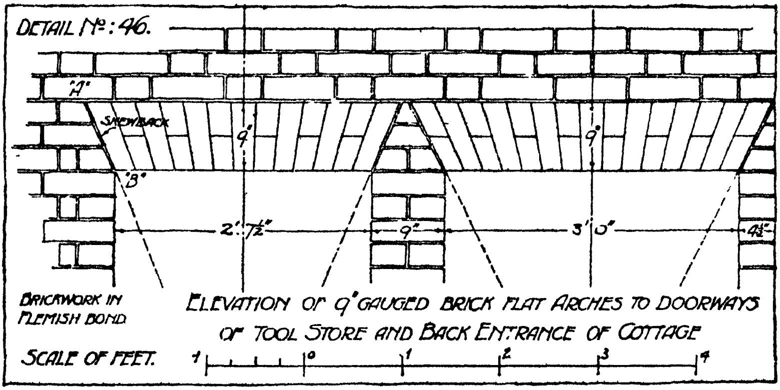
A gauged arch must have its maximum brick thickness on the *extrados* curve because the brick is to be cut down to the wedge form. Hence divide the extrados into an odd number of equal parts by trial, so that the divisions do not exceed 3″, and radiate the joints from the centre of curvature.

91. Flat arches to back doorways of cottage. Flat arches (or those nearly flat) are very common in brickwork and are suitably executed in gauged work.

This form of arch has been selected to span the back doorway and tool store door openings, and in our detail No. 46 these are drawn with perfectly flat soffits. In a previous clause, we referred

to the fact that while keeping the top surface flat a slight rise and curvature may be given to the soffit, which is suitably 1″ rise to 30″ of span. This "camber" reduces the appearance of "drooping" or "sagging," which is very noticeable when the soffit is horizontal. Such camber is commonly marked out in the first instance by bending a flexible rod, carefully adjusted to the desired curve, passing through springing and crown, then drawing the outline, marking the joints and preparing a wood pattern called a "templet." The bricklayer's setting out in obtaining individual patterns for cutting these gauged voussoirs is a special process and does not concern us here.

Consider now the method of setting out the arch. With other arches we should first settle the angle of the skewbacks by radiating them from the centre of curvature. But in this case we have no centre of curvature, so we need to select a point which shall serve



ELEVATION OF 9" GAUGED BRICK FLAT ARCHES TO DOORWAYS OF TOOL STORE AND BACK ENTRANCE OF COTTAGE

the purpose of a "radial centre" for the jointing. It is very common to determine this by constructing an equilateral triangle upon the springing line with its vertex downwards; the skewbacks are then inclined at 60° to the horizontal. This results in the necessity for neat subdivision of the top bed into parts by trial or by geometrical construction.

A practical and much superior method of setting out such an arch on drawing paper is available. It consists of placing the key brick in position, 3″ wide and symmetrical about the centre line, and setting out 3″ steps on the extrados until the number of voussoirs is one more than the number of 3″ divisions in half the width of the opening. The skewback is then formed by connecting this point on the extrados with the extreme point of the intrados, and producing until it cuts the centre line of the opening. The joints of the voussoirs may then be drawn radiating from this point on the centre line to the various points on the extrados.

If objection be taken to the measurements being placed along the horizontal extrados when the voussoirs are really sloping, instead of measuring normally, observe that the difference between the normal measurement and horizontal one in the 3″ length is so very small, even in the first voussoir, as to be entirely negligible in a drawing.

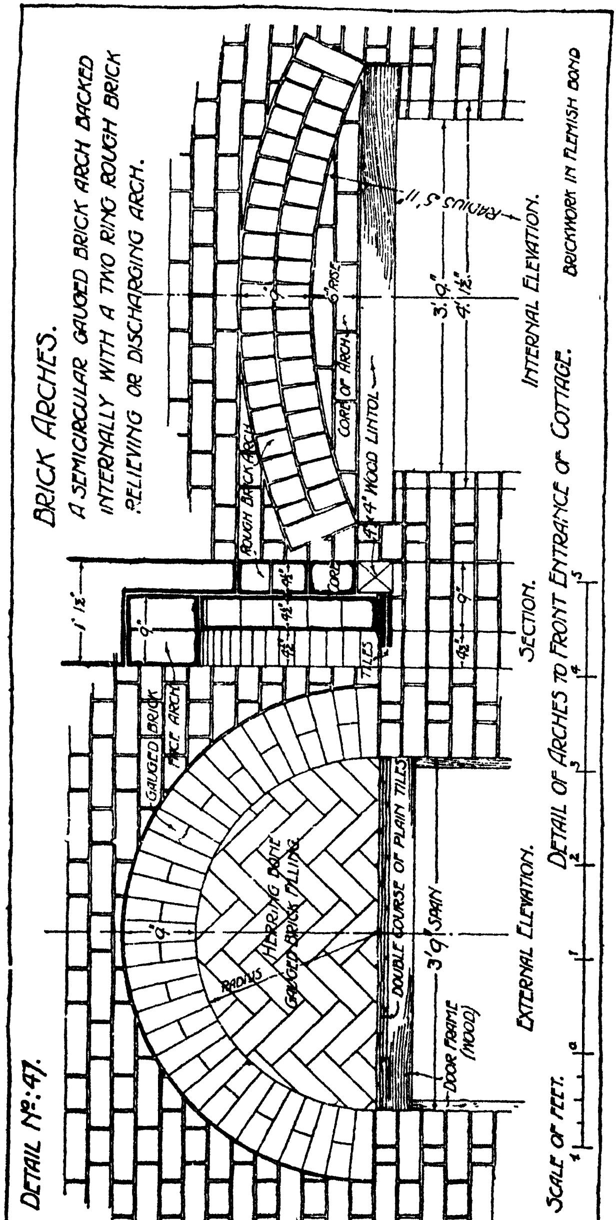
The arches shown are 9″ deep, and a 9″ deep arch cannot be constructed from the standard size of brick; in this case the "springing voussoir" measures 10½″ lengthwise between the long points *A* to *B*. It therefore follows that cutters of a special size must be supplied to produce a gauged arch without introducing face joints within the depth, or that "purpose made" arch bricks are required. Reviewing the "flat arch" as a structure, it is clear that most of the joints vary considerably from the position of "normals" to the outline, for to be *normal* they would be *vertical.* The result is an accumulation of voussoirs with numerous acute angles which is a structural fault and causes liability to damage during erection; but the arch is sound and good under ordinary conditions and moderate loads, largely because it is made deep and rigid, and the bonding of the plain walling above it causes an arch action which relieves it considerably of load.

92. Supporting flat arches. Flat and segmental arches with little rise, whose soffits are only 4½″ long, are supported during building by "flat pieces" or "camber slips" cut to the shape of the soffit out of 3″ or 4″ by 4″ material which is held in position for setting the arch in one of several ways.

In common work pieces of wood about 2′ long and 4″ × 1¼″ are nailed to the comparatively soft mortar joints of the reveals and flat against their faces; the slip rests upon them. When the supports are removed the nail holes are stopped. In better work two light posts of the correct length are often placed against the reveals, resting on the cill, a horizontal strut placed lightly between these and the camber slip laid upon them; pairs of folding wedges intervene to allow for easing the "slip" downwards when the arch is complete. For complete details of supports and easing wedges see chapter on Temporary Carpentry, detail No. 68.

93. Semicircular arches. The front entrance doorway to our cottage has a semicircular arch spanning it externally, with a "herring-bone" gauged brick filling to the semicircle enclosed between the springing line and the soffit; the enclosed space is called a "tympanum." Detail No. 47.

The face arch does not pass through the full thickness of the external wall (13½″) but is only 9″ long by 9″ deep leaving 4½″ of internal walling to be otherwise supported as shown in cross section.


DETAIL No. 47.
BRICK ARCHES.
A SEMICIRCULAR GAUGED BRICK ARCH BACKED INTERNALLY WITH A TWO RING ROUGH BRICK RELIEVING OR DISCHARGING ARCH.
EXTERNAL ELEVATION.
SECTION.
INTERNAL ELEVATION.
DETAIL OF ARCHES TO FRONT ENTRANCE OF COTTAGE.
BRICKWORK IN FLEMISH BOND
SCALE OF FEET.
GAUGED BRICK FACE ARCH
HERRING BONE GAUGED BRICK FILLING
RADIUS
DOUBLE COURSE OF PLAIN TILES
3'9" SPAN
DOOR FRAME (WOOD)
TILES
ROUGH BRICK ARCH
CORE OF ARCH
4" x 4" WOOD LINTOL
6" RISE
RADIUS 5' 11"
1' 1½"
3' 9"
4' 1½"

A support is also required for the herring-bone filling to the tympanum, the latter being only 4½″ thick and therefore recessed 4½″ from the external face of the wall. To carry the diaper we have utilised the head of the door frame, making it strong enough for its purpose and protecting it by tile courses. The remaining part of the wall is carried internally by a 4″ × 3″ wood lintol, relieved by a segmental rough ring arch, seen in detail No. 47.

Being a "gauged" arch the external semicircle is set out to give the odd number of uniform divisions, each within 3″, and the joints are radiated from the centre of the semicircle; also, because the depth is 9″ and the soffit exceeds 4½″, bonding is necessary, headers and stretchers being alternately used, but no closers.

94. Relieving arches to "window openings" and "external door" openings. We have previously illustrated the application of segmental relieving arches to door openings in internal walls, and made reference to their use for backs of window openings in external walls. It is now necessary to study the application to varying conditions of "face arch."

If an opening be bridged externally by a face arch 4½″ long, and the wall is 9″ or 13½″ thick, we have some walling behind the reveal, viz. the width of the recessed jamb, to support. Let the face arch be "flat," "cambered," or a "flat segment" whose rise does not exceed 3″, then it becomes easy to transform the shape of the opening to a square outline at the head of the recess by placing a wood lintol 3″ above the soffit of the face arch to span the recessed part, and having 4½″ bearing at each end upon the jambs. In an arch with a curved soffit we thus form a top recess of greater depth at the ends than in the centre; this is no inconvenience but rather an advantage, because a square headed frame may be then fitted into the opening. At the same time the architectural effect of the curved head is partially lost.

We are now able to see that the mode of internal support will be the same for all arched openings, where the head of the opening may be "squared" at the internal recess, and a relieving arch employed to span completely the wood lintol. The length of the face arch is equal to the breadth of the reveal and the back arch has a length equal to the width of the recessed jamb, and, while the two meet, they are quite independent of each other.

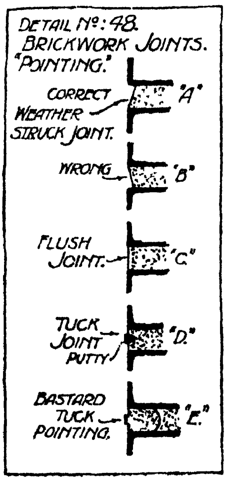
In all cases the wood lintol should be so placed that its soffit coincides with a bed joint of the brickwork.

A further reference to the internal elevation of the entrance doorway to cottage, detail No. 47, will show that the above method of support to the back wall was possible, because the head of the opening was first squared by the tympanum filling upon the door frame.

95. Semicircular openings. When an opening with recessed jambs is to be maintained of a semicircular or segmental form inside and out, the support to the interior is provided in a different fashion. The lintol has to be abandoned and an arch, usually similar in form to the face arch, is employed, its curves running parallel to those of the external arch, but lifted, or expanded in size, to provide the continuation of the recess round the head of the opening.

The exterior arch may be "gauged," or "purpose made," or be constructed of "stone"; and the interior one may be "rough," or "axed" and neither arch is bonded to the other.

96. Mortar joints. When mortar is laid in the joints of brickwork for uniting the pieces of material and filling the voids it is more or less porous, and, though it may serve to fill the joints and perform the other functions allotted to it, there exists many airholes and crevices after the evaporation of moisture is complete and "setting" has taken place. These defects allow absorption and conduction of moisture to a considerable depth, and steps are taken to ensure an effective joint by: (*a*) compressing and smoothing the surface exposed on the wall face, (*b*) by removing the bedding mortar to a depth of $\frac{1}{2}''$ to $\frac{5}{8}''$ and replacing by cement mortar or other reliable compound.



The first process is included in the formation of the finished joint performed upon the original mortar; the second is termed "pointing."

"Jointing" is the shaping of the exposed mortar at the exposed bed and vertical joints, the common forms being named "flush" and "struck."

Flush joints are in the same plane as the wall face and should only be used for internal faces intended to be limewashed. It would be applied in the interior of the workshop—see detail No. 48 C.

Struck joints are bevelled by compressing the mortar along one edge of the joint with the tip of the trowel. Detail No. 48, A and B, shows two forms. The first is correct, its slope discharging water rapidly from the joint, and, if not too deeply impressed, emphasises the joint to a sufficient degree by the cast shadow from the overhanging edge. It may be most conveniently made when working from an external scaffold, so that the workman faces the wall in performing the operation. To attain the smooth, dense face, the trowel should be worked in "one direction" several times across the joint. Serious defects observed during the process should be remedied by raking and refilling the defective portion. The short

vertical joints may be bevelled in either direction or shaped to a "vee" section which is preferable for obtaining a satisfactory finish at the intersection with the bed joints.

The "second" form of joint is bad and should not be allowed. It leads water into the joint by retaining it on the projecting edge and destroys all the value obtained by smoothing and compressing the surface. This joint is encouraged by the method adopted of building a wall from internal scaffolding and working overhand; the workman leans over the finished part and strikes the joint during the progress of the work in the easiest form presenting itself. He can see to produce the incorrect bevel, while the better form, if attempted, would be largely out of sight and thus irregularly accomplished.

Jointing of slow setting mortar should be done just as the surface begins to harden, as wet mortar cannot be compressed satisfactorily. Overhand work is therefore doubly defective because the workman quickly gets out of reach of the joints he wishes to strike, and he must perforce do the work required with the mortar in an unsatisfactory condition.

97. Tuck pointing is a process adopted in renovating old brickwork whose units are ragged at the joints, either through deterioration of the bricks, or possibly by careless raking during the process of repair (see detail No. 48, D and E).

The joints are first cleared by cutting out the old mortar to a depth of $\frac{1}{2}''$, brushing off the lime dust and thoroughly wetting them; filling is then done by "hard-setting" mortar which is trowelled flush at the joints and a shallow groove $\frac{3}{16}''$ wide cut in it. When set the whole face is coloured by pigments and chemicals, ferrous sulphate (commonly known as copperas or green vitriol) being the usual base employed. When mixed with water, and a colouring pigment added, a uniformly tinted ground is obtained covering the joints completely. The grooved joint is then filled with lime putty, allowed to project $\frac{1}{16}''$ to $\frac{1}{8}''$, cut clean and true to the width of the original groove and when finished shows *temporarily* a neatly jointed mass of brickwork. It cannot be advocated as a satisfactory method of renovating, because it is not durable, is deceptive in appearance, and the "tucking" of white lime putty in no way adds to the efficiency of the joint. After a time the colouring of copperas is weathered off and the wide joints become distinctly visible.

Another form of tuck pointing (or rather an imitation of it) is called "Bastard Tuck," which has a projecting band trimmed upon the face of the pointing mortar. Seen from a short distance the shadow cast by the projection gives a dark line resembling a fine joint in appearance. Projections of any kind from a joint which are capable of retaining water should be avoided.

98. Pointing. Ordinary pointing to brick or stonework is executed in "portland cement" mortar or "hydraulic lime" mortar. As described for tuck pointing, the joints are cleared to a depth of $\frac{1}{2}''$ or $\frac{5}{8}''$, brushed clean, wetted and stopped with mortar, the face of the joint being "struck" or formed to a "vee" section. The object of pointing is to remedy known defects in external walls which have been subjected to the weather, or to anticipate such defects in particularly exposed positions; a third reason, perhaps, is to make good the joints of a wall which, while not conveying wet to the interior, have deteriorated and become irregular and unsightly.

CHAPTER FIVE

BRICKWORK

Fireplace and Chimney Construction

99. Where open fireplaces are required for the warming of rooms, means have to be provided for the conveyance of smoke and products of combustion to the external atmosphere, without danger to the structure.

100. Bye-laws. To control the building of fireplaces, their accessories and connections, bye-laws, based upon the Local Government Board's model bye-laws, are in force in nearly every locality.

We do not quote these in the present volume, but meet their requirements as far as the circumstances of our examples demand.

101. Flues. Every fireplace needs a separate channel for the passage of smoke, which is called a "smoke flue."

102. Fireplace. The fireplace is the recess at the entrance to the flue, in which the firegrate is placed; the entrance to the flue from the fireplace is called its "mouth" and the sizes of fireplace and flue vary with the type and size of firegrate to be employed.

Fireplaces are recessed to give a direct entrance to the flue and avoid escape of smoke into the room. Where there are subsidiary flues, the mouth of the main flue is funnel-shaped so as to gather conveniently the smoke, etc.; this occurs in the ordinary "close fire kitchen range." Otherwise, the funnel-shaped opening is unnecessary, particularly for the modern "slow combustion firegrates" and a central opening is the best arrangement.

Funnel-shaped openings are very common though in brick buildings, because the flues may be easily shaped to "gather," that is to turn them to one side when required.

103. Breasts and stack. The walling containing flues and fireplaces is termed the "chimney breast" or "breast walling," except where it rises above the roof, or clear of the surrounding structure; it is then known as a "chimney stack."

104. Jambs. Attached piers on each side of a fireplace opening supporting the "breasts" above are called "jambs," and the jamb sometimes contains a flue passing upwards from a fireplace in a lower storey.

105. Dimensions of parts. The following dimensions and conditions are observed in our construction:

Jambs may not be less than 9″ wide; this is required for strength. Most modern mantelpieces demand 13½″ jambs.

Enclosing walls to flues (breast walling) must be at least 4½″ thick; externally they are better 9″ thick.

Division walls between two or more flues are 4½″—these divisions are called "withs."

Walling above fireplace openings is usually supported by a brick arch, which needs a metal support and tie called a "chimney or camber bar."

Flues must be at least 9″ × 9″, if square; many bye-laws require 13″ × 9″ when constructed in brickwork.

Chimney stacks to dwelling houses are usually built with 4½″ external walls; but where the external wall behind a fireplace is made 9″ the stack might usefully be carried up at this thickness all round, the breast walling being corbelled out for the purpose within the roof space.

106. Economy in construction. To economise in construction and to increase the efficiency of smoke flues, they are grouped together where convenient, the fireplaces being arranged in tiers throughout the height of a building, and the smoke flues turned to the right or left during their ascent, to pass any fireplace interrupting its continuance in a vertical line. Above the tier of fireplaces, they may then be gathered inwards to form a "stack."

107. Cottage flues. Referring to the general plans, it will be seen that there are two fireplaces immediately over each other in the side walls of the cottage, for the living room and bedroom respectively.

108. Fireplace openings. Considering only the detailed construction of fireplaces and flues, our first object is to provide the fireplace recess. This is formed by a pair of jambs, spanned by either (*a*) a stone lintol, (*b*) a brick arch or (*c*) a concrete lintol.

109. Brick arches are common to most districts and we have adopted this method for our example. Other methods will be dealt with in Vol. II.

The rough arch supporting the breast walling is only 4½″ long (back to front) and is prevented from overturning the jambs due to its thrust by a 2″ × ½″ wrought iron "camber" or "chimney" bar, bent to the intrados curve, carried by a level extension at the ends and providing a *tie* by dividing the ends and turning the cut portions upwards and downwards as in detail No. 49 at "D." This operation is often termed "caulking," but this is not a good term to employ. No support for the arch is required during construction other than the "camber bar."

In some districts camber bars are not used, but hoop iron is laid *over* the arch in two strips and carried along the level bed joint of the jambs for a distance of at least 9″. This *ties* the arch fairly well, but does not *support* it, and turning pieces of wood are required to support the rough arch in a manner similar to that shown in detail No. 68 A.

The depth of the arch in our detail is 9″; this may be taken as suitable for spans *greater than* 2′ 6″, and a single $4\frac{1}{2}$″ ring for spans *less than* 2′ 6″.

110. Flues. The flues are 9″ square and are enclosed in $4\frac{1}{2}$″ walls built in stretching bond. Where straight lengths of flue occur the bond is very simple, but in the flue entrance and at bends a system of offsets and corbelling is adopted, the steps varying from $\frac{3}{4}$″ to $2\frac{1}{4}$″ according to the curvature required, and the bonding of the breast walling is cut to suit the positions of the corbel courses. The detail explains these flue turnings and funnel-shaped openings clearly. It is held that every flue must be bent, to prevent rain dropping directly upon a fire (of the open type) and to assist in preventing down draughts. The latter point is a mistake, for the bend acts against the upward current of smoke and the downward current of wind quite proportionately. Further, the most modern firegrates of the slow combustion type, with flue controlling canopies, do not require bent flues to prevent rain dropping on to the fire, because the smoke comes forward first, passes into the projecting hood and curls backward into the flue; rain would thus fall upon the flat "soot shelf" behind. Straight flues are the most efficient, if free from constructive faults in size, length and situation, but flues must often be turned to avoid interference with fireplace openings immediately over, as in the case shown in detail No. 49.

111. Flue linings. In addition to sound building, brick and stone flues require to be "lined" for two reasons:

(*a*) To make the flue airtight, so that cold air may not enter at faulty joints, and reduce the efficiency of the flue.

(*b*) To obtain a smooth surface which offers little resistance to the ascending gases, and to fill the triangular spaces at offsets and corbelling where the flues are curved.

The lining of plaster is, in modern work, a "rendering" of portland cement mortar $\frac{1}{2}$″ to $\frac{5}{8}$″ thick, well trowelled, and rounded at the angles, and which is added in vertical stages as the work proceeds.

An older method—still in use in some districts—is to line the flue with a compound of mortar and cow-dung, in the ratio of 3 to 1, giving a smooth, tough covering. This method was called "pargetting" or "parging" and the name is commonly applied to any form of flue rendering, especially to common mortar or its compounds.

Fireclay and other flue linings are considered in a later volume.

112. Coring is an operation necessary in pargetted flues for ensuring that the channel is free from pieces of broken material accidentally dropped into it during the progress of the work. The only satisfactory method is to use a sack or bundle of hay which is drawn up the flue by means of a rope and kept within easy reach of the worker so that droppings of mortar and scraps of brick may be removed from time to time. Pargetting is accomplished between the stages and the surfaces smoothed before raising the core.

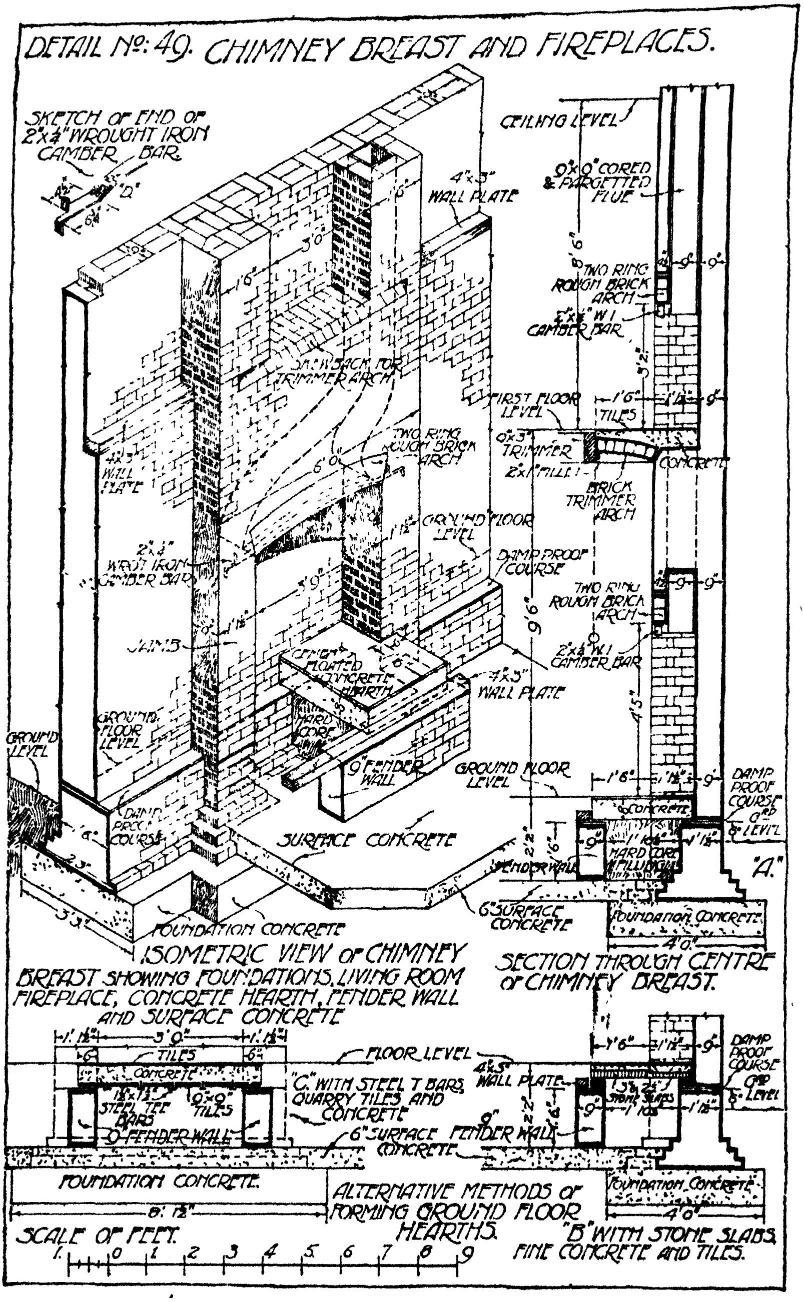
113. Hearths. In order to prevent fire, which may possibly occur by hot ashes falling from the firegrate, or by heat being conducted through the immediately surrounding materials, the floor beneath the firegrate and for some distance in front, must be of fire-resisting construction kept sufficiently distant from the heated zone to eliminate danger.

A space at least 6″ longer than the fireplace opening, at each side, and 18″ wide measured from the face of the jambs, is therefore constructed with brick, concrete, stone or tiles—or combinations of these materials—finished level with the surrounding floor. This fire-resisting area is called the "hearth," that portion between the jambs and within the opening being distinguished by the term "back hearth," while the part projecting into the room is called the "front hearth."

Should the floor be a basement or ground floor, made of concrete or flags laid direct on dry filling over rammed earth, no special preparation is necessary. The floor covering merely passes into the fireplace opening to the back, filling up the space completely.

114. Ground floor to cottage. In the ground floor to cottage we have a wooden floor, whose level is 2′ 8″ from the foundation concrete and 2′ 2″ from the site concrete. The chimney is heavy and carried to a height of about 36 feet, and thus requires a sound foundation. Our provision is shown in the vertical section and isometric view of detail No. 49 in which a solid rectangular block of concrete, about 12″ thick as in the main foundation, is spread out to receive the footings for the jambs which support the breast walling.

It should be noted that the chimney breast walling projects 9″ within the building, but the piers or jambs of the ground floor fireplace are 1′ 1½″ wide, so that the three courses of footings used for the external wall will also suffice here. The foundation concrete requires to be 8′ 1½″ × 4′ 0″ under the chimney walling, and the 6″ thickness of surface concrete serves to support a low 9″ wall, called a "fender" wall, which is built in front of the opening, to carry the hearth and floor timbers.


DETAIL No: 49. CHIMNEY BREAST AND FIREPLACES.
SKETCH OF END OF 2"x¾" WROUGHT IRON CAMBER BAR.
CEILING LEVEL
4"x3" WALL PLATE
9"x9" CORED & PARGETTED FLUE
TWO RING ROUGH BRICK ARCH
2"x¾" W.I. CAMBER BAR
SKEWBACK FOR TRIMMER ARCH
FIRST FLOOR LEVEL
TILES
9"x3" TRIMMER
2"x1" FILLET
CONCRETE
BRICK TRIMMER ARCH
TWO RING ROUGH BRICK ARCH
4"x3" WALL PLATE
GROUND FLOOR LEVEL
DAMP PROOF COURSE
2"x¾" WROT IRON CAMBER BAR
JAMBS
CEMENT FLOATED CONCRETE HEARTH
HARD CORE
GROUND LEVEL
9" FENDER WALL
SURFACE CONCRETE
FOUNDATION CONCRETE
6" SURFACE CONCRETE
HARD CORE & FILLING
FOUNDATION CONCRETE
"A."
ISOMETRIC VIEW OF CHIMNEY BREAST SHOWING FOUNDATIONS, LIVING ROOM FIREPLACE, CONCRETE HEARTH, FENDER WALL AND SURFACE CONCRETE
SECTION THROUGH CENTRE OF CHIMNEY BREAST.
FLOOR LEVEL
TILES
CONCRETE
1½"x1½" STEEL TEE BARS
9"x9" TILES
9" FENDER WALL
"C" WITH STEEL T BARS, QUARRY TILES AND CONCRETE
4"x3" WALL PLATE
9" FENDER WALL
6" SURFACE CONCRETE
STONE SLABS
DAMP PROOF COURSE
FOUNDATION CONCRETE
ALTERNATIVE METHODS OF FORMING GROUND FLOOR HEARTHS.
"B" WITH STONE SLABS, FINE CONCRETE AND TILES.
SCALE OF FEET.

115. Ground floor hearth. Ground floor hearths to boarded floors are usually carried upon these fender walls, and the hearth may be of

(*a*) one slab of concrete 6″ to 8″ thick, laid on rough filling within the fender and recess as shown at "A" detail No. 49, or

(*b*) a stone slab in two pieces, one, say 2½″ thick, built into the jambs for the back hearth—or laid on corbel courses—and another, say 3″ thick, resting on the fender wall at the front edge and ends. If thin and weak, a steel tee or angle bar may be placed across the fender walls flat side up, to give it support at the back edge.

These flags are kept 2″ below the floor level, flushed level with the joists in fine concrete, and finished after the floor-boards are laid by bedding glazed tiles in cement—see "B" detail No. 49. All hearths to be tiles are therefore set out in suitable tile sizes.

(*c*) Rough tiles of any kind may be used to support the concrete by placing small iron or steel tee bars (⊥) at suitable distances to support the tiles, then depositing concrete to the required depth. This is shown at "C" in the same detail.

The fender wall serves two purposes; 4½″ of bearing is occupied by the wall plate supporting floor-timbers and the remainder by the slab.

116. Upper floors. Hearths to "upper floors of wood" are treated in a different manner.

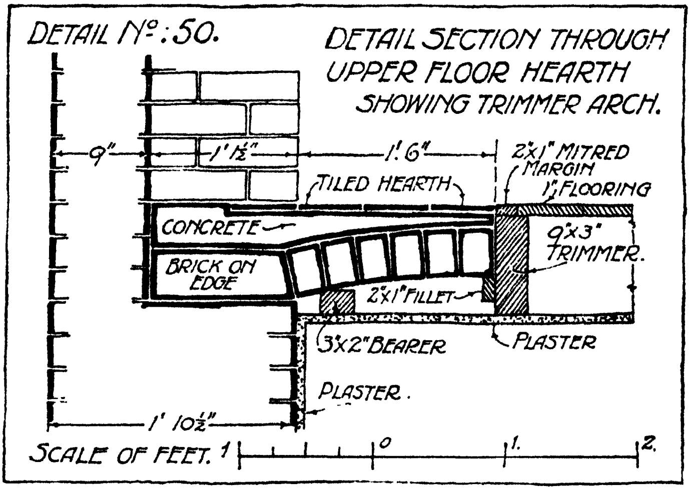
First, the floor timbers require spacing round the hearth and 1½″ clear of the breast or jamb; no timber may enter breast walling for support except it be more than 9″ from the inside of a flue.

The constructive difficulty we have to meet here is to provide an incombustible support for the "hearth surface." In stone districts this is again easily overcome. A bearer 3″ × 2″ set edgewise is nailed all round the opening of the hearth against the trimming timbers, placed 4″ from the top of the joist, and a 3″ stone slab laid upon it, forming the base of the front hearth. A back hearth slab, 2″ thick, is laid on the brickwork of the breast *within* the fireplace opening, so that its top surface is level with the front hearth slab or, it *may* be, at the floor level. The "hearth finish" may then be accomplished as described for ground floors.

Note. For small fireplaces it is common to build *one* 3″ stone slab into the breasts, 4½″ longer than the opening at each end, letting it overhang at the front and act as a cantilever. When the trimming of the floor is completed and settlement of the brickwork or masonry has taken place a supporting fillet is nailed to the cross timber, beneath the slab. These slabs are in danger of breakage during building operations.

117. Trimmer arch. The oldest and most general method of supporting a first floor hearth is to build a brick "trimmer arch," which is usually a 4½″ rough semi-arch springing from the breast

wall and resting at its crown against the trimmer. A fillet of wood is nailed under the crown bricks to ensure that the arch shall not be disturbed due to shrinkage of the timber or failure of the mortar to adhere there—which is fairly certain. A skewback is provided for the trimmer arch, by a course of bricks on edge cut to the bevel as shown in section and sketch.



Trimmer arches should spring from a little above the level of the underside of the joists in order to allow for the insertion of a bearer to carry the ceiling; this bearer is shown in section at detail No. 50. The top of the trimmer arch should rise to within 1½" of the top edge of the trimmer.

The arch is covered with concrete whose level is ¾" or ⅞" below the finished floor surface; ½" tiles and bedding are allowed for.

For reasons to be described in the chapter on Flooring, trimmer arches should extend past the fireplace opening at least 9" at each end and if the jambs are wider than 18" their ends must not be further from the trimming joist than 12".

CHAPTER SIX

MASONRY

118. Masonry is that branch of building in which the construction is of stone, though in some districts the term includes bricklaying. Stone may be used "alone" in the construction of the walls of a building or may be combined with brick as shown in some of our details.

119. Labour. For straight walls of a cheap character the stone may be laid as "found," in roughly quarried pieces broken up judiciously with the hammer, but a large quantity of masonry work requires more or less labour to be expended on reducing rough blocks to some preconceived shape to suit the detail of the building.

Hence masonry becomes subdivided into "building work" (the setting of worked stones and building of rough walls) and "banker work" (preparing stones for the builder to lay).

120. Setting stones with brickwork. Bricklayers are often called upon to set isolated pieces of stone along with the common mass of brickwork, the pieces including thresholds, cills, lintols, templates, bond and hinge stones, pier caps and steps.

These are prepared by the "banker" mason and delivered to the bricklayer ready for setting. They must be of suitable dimensions for bonding to the brickwork.

121. Stone walls. We shall now consider the work of the "builder mason" in roughly prepared stone as delivered from the quarry, ready for his handling in the erection of walls.

Stone walls may be erected of:

(*a*) Uncut stone.

(*b*) Roughly squared material.

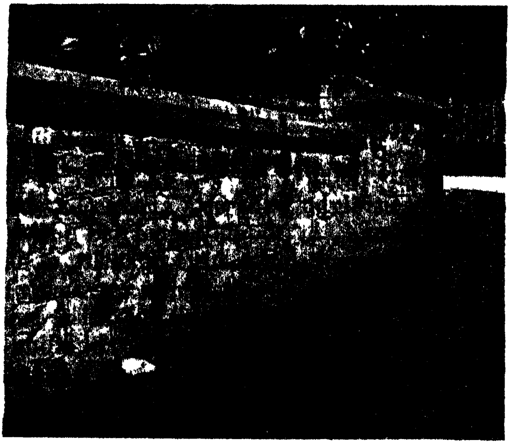
(*c*) Carefully dressed blocks cut to accurate sizes.

The resulting wall is named according to the nature of the finish upon the material employed in its construction.

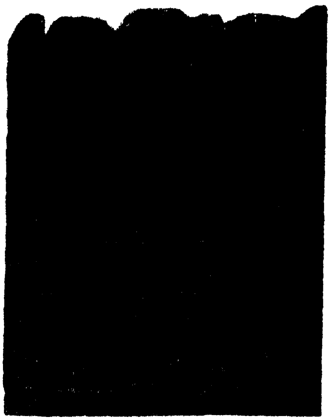
Random Rubble (Uncut Stone)

122. Walls built of rough, uncut stone are called "random rubble walls," the blocks being of all shapes and sizes and picked up more or less at random from the mass. They are placed in position with no cutting or labour apart from snapping inconvenient corners off with the walling hammer. Large stones should be fairly well distributed throughout the mass and lap in both directions should be maintained to secure "bond."

DETAIL No: 51. MASONRY WALLING.



UNCOURSED RANDOM RUBBLE IN BOUNDARY WALL.



RANDOM RUBBLE.

POLYGONAL STONES WITH CEMENT POINTED JOINTS.

ROUGHLY COURSED AND LAID WITH DRY JOINTS

Random rubble walls of flat-bedded stuff carefully selected when building and laid in good mortar make very good and stable walls, and random rubble as a "class" of walling provides a wide scope for artistic treatment.

Detail No. 51 shows three examples of random rubble walling The first illustrates uncoursed sandstone built in mortar; the second shows random pieces of limestone "hammer dressed" to rough polygonal forms and producing roughly parallel joints which are bedded in mortar and pointed in cement; the third example is a roughly coursed sandstone wall laid without mortar and is commonly used for boundary walls between two properties.

In all rubble work the beds of the stone average 6″ to 9″ wide, and have a length up to 18″. The walls average 16″ to 18″ thick.

Thin walls cannot usefully be built of random stone because two fair faces are almost impossible to obtain without two sets of stones in a course. The thinnest walls where two faces are visible are 12″ thick.

123. Coursed random. A further variation on the above types of walling is to erect the wall in courses. The stones are more carefully selected, so that at intervals of 12″ to 18″ level beds are obtained throughout the length of the wall. The appearance is stronger—though less artistic—more care is taken in bedding and flushing with mortar and the wall is better adapted for transmitting load.

Walls of Roughly Squared Material

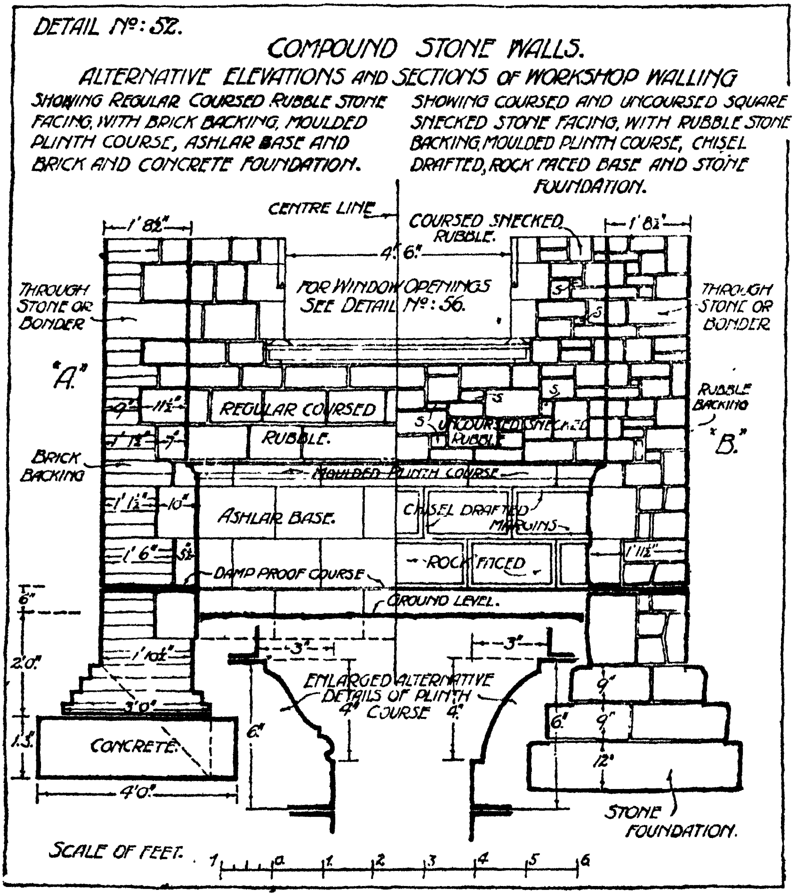
124. Stones of sufficiently good quality and definite bed, and yet not large enough for making cills, lintols, thresholds, etc., or specially large stones, are carefully split at the quarry into thicknesses varying from 5″ to 12″, lengths from 10″ to 24″ and beds from 5″ to 11″ wide. (These are rough limits only and do not apply to any one locality.)

125. Regular coursed rubble. Such stones are used for regular coursed rubble; they are suited to good work where a sound brick backing is intended for a "stone faced" wall, thoroughly bonded throughout as applied in detail No. 52 A. In this detail the stone courses vary from 6″ to 12″ (9″ average), and the least allowable lap is 2″ but should *average* 3″ to 4″ as a minimum, short laps being few and well distributed.

Thick beds of stone in outer walls are not so pleasing in appearance as thinner beds, and in many stone producing areas thick bedded stuff cannot be consistently obtained. It has therefore become more general in these districts to split the stone into thinner pieces varying from 4½″ to 7″ deep, cutting the lengths from 10″ to 20″ and the beds 5″ or 6″ in width.

126. Compound walls. In the northern counties very much compound walling is done, walls being faced with "cut rubble" and backed with "random rubble" or with "brickwork."

The usual arrangement is to build two separate walls, either backed against each other or with a cavity between, and to insert one



"through bonder" at least to each square yard of face walling. Walls from 14" to 18" thick are so built, and employed generally for buildings of moderate dimensions, domestic or otherwise.

For stability, such walls are very much weaker than brick walls of the same thickness, but they serve their purpose quite satisfactorily (being thick), are cheaper than brick in these particular localities, and keep out the cold extremely well. Assuming the face wall to

be 6″ thick and the rubble back 8″ to 9″, a cavity about 3″ wide would result. This may be left vacant as stated above, or filled with dry rubble, or again with rubble scraps in mortar, without any attempt at bonding. Experience teaches that it is better to fill the cavity (possibly not to the full height) to avoid the insanitary conditions which sometimes arise in connection with hollow walls. "Dry filling" resists penetration of damp better than "mortar filling."

127. Snecked rubble. Snecked rubble is another form of partially cut walling. The face stones are split to flat beds and the vertical edges roughly squared with the hammer—or hammer and chisel—but the blocks are allowed to accumulate of largely varying sizes.

DETAIL No: 53. MASONRY WALLING.

SQUARE SNECKED RUBBLE.

SQUARED RANDOM RUBBLE.
SIMILAR TO SNECKED RUBBLE.

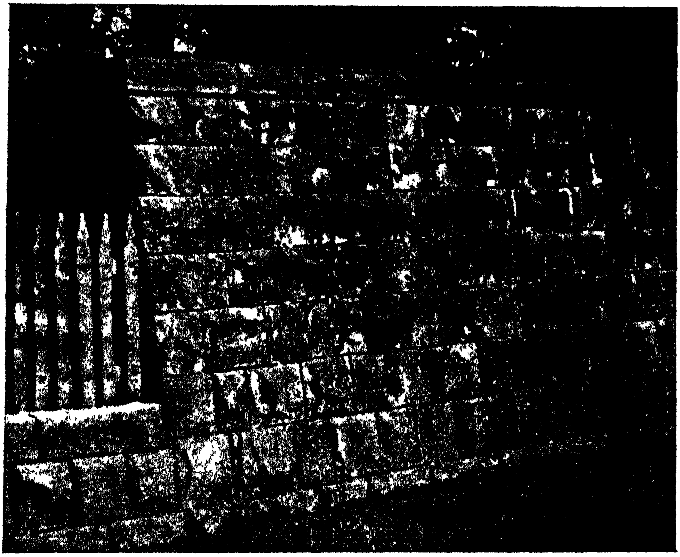
Much skill is required in choosing and setting the stone to obtain a bond similar to detail No. 52 B, and in utilising the stones to the best advantage and with the least waste.

In this case the work is "coursed" to suit the window "quoins" or the quoin stones prepared to suit the courses, this being a matter for choice. Detail No. 53 is a photo reproduction of two pieces of snecked rubble wall, one of these having, incidentally, a cut stone air inlet for ventilation.

In the true form of "snecked rubble"—which has many variations—the association of two stones, or pairs of stones, of varying depth causes the use of small rectangular fillings marked "S" in detail No. 52 B. These are called "snecks," and fill what appears to be a sneck or rebate formed by the adjoining stones.

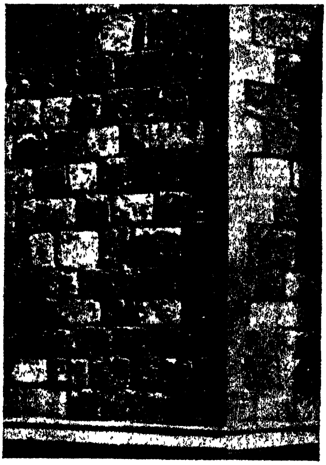
Observe that the beds of the snecked rubble wall are level in the section, while those of the random backing vary a little and bevelled "edge joints" also occur; to cut these would be wasteful.

DETAIL Nº: 54 MASONRY.

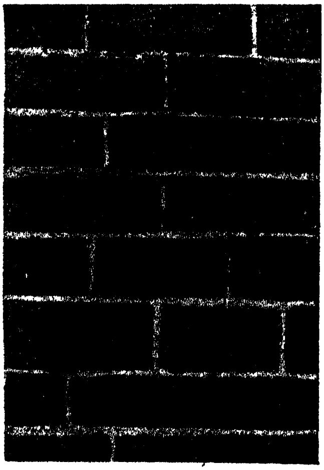


BLOCK IN COURSE WALLING IN A BOUNDARY WALL.

DETAIL Nº: 55. SQUARE COURSED RUBBLE.



WITH ROCK FACE AND ASHLAR QUOINS.



WITH STRAIGHT CUT FACE.

128. Block in course. It might be noted here that regular coursed rubble when in very large deep courses is often called "block in course." An example is shown in the photograph, detail No. 54.

129. Rubble face. Regular coursed rubble is commonly built with one of two kinds of surface finish:

(*a*) "Hammer dressed," "pitch faced" or "rock faced."

(*b*) "Straight cut" face.

The two illustrations in detail No. 55 are from photographs showing these surfaces applied in construction.

The "hammer dressed" face is obtained by leaving the area rough and projecting, the *edges only* being brought approximately into one plane by marking the cleaved block round the beds and joints and "pitching" or knocking off the front angles to these lines obliquely. The stones are walled to this plane of dressing, the rock face standing beyond the real "face plane" of the work. "Straight cut" or plain faced stones are more costly than rock faced ones, being partially cut with the hammer and chisel from bigger stuff and broken in a plane approximately perpendicular to the beds. The face is fairly rough but with no outstanding parts.

Snecked rubble may have *either* finish, but usually in domestic building the face is "straight cut" and in engineering work is "rock faced."

130. Quoins. When quoins are to be constructed in coursed rubble walling they may be treated as shown at the left of detail No. 55, where the length is set alternately in each direction. In this detail the quoin stones are of ashlar finish, see paragraph 132.

131. Reveals. Reveals in stonework should be dressed to a plane surface at 90° to the wall face, and thus provide a "fair opening" showing a uniform margin to the wooden frame or other fitting to the opening.

Carefully Dressed Blocks

132. Walls built of carefully dressed blocks with accurate bedding and jointing are termed "Ashlar" walls.

Ashlar is the highest type of stone walling, comparing with gauged work in brick. Good ashlar blocks when assembled and bedded in mortar should produce joints not exceeding $\frac{3}{16}''$ thick. It is possible to obtain thinner joints ($\frac{1}{8}''$ or even $\frac{1}{16}''$) but any increase on $\frac{3}{16}''$ is very imperfect work, unless purposely done with some motive of design.

Ashlar is often stated to consist of courses not less than 12″ deep. This is an imperfect definition. All stonework of whatever dimensions correctly dressed to plane faces should be classed as ashlar, but it is obviously to the interests of all concerned not to multiply

the number of beds and joints to be prepared, and also the labour of surface work, by using small stones. Generally, ashlar is not employed in plain walling in courses less than 8″ thick, and averages about 10″, but in connection with moulded work it must suit the dimensions of related features and contiguous parts.

Workshop

133. We shall now consider in detail the application of previously described walls to the construction of the stonework elevations of the workshop.

The front gable and side elevation of the workshop are of regular coursed rubble—or snecked rubble as an alternative—with ashlar plinth, quoins, heads, cills, reveals, copings and arch.

We shall take these in order as they arise, commencing with the foundations as before, when detailing the brickwork.

134. Foundations. Foundations to the stone wall, detail No. 52, are constructed of large "found" stones, roughly squared and from 12″ downwards in thickness. They are arranged as footings, laid directly upon levelled and rammed earth and have a base at least twice the thickness of the main wall. The base course should have no joints in its cross section, so that every stone is transmitting load across the whole width of its base. Upper courses may then be bonded as desired, and the foundation walls carried up in flat bedded "random rubble," in good mortar and well bonded, to within a few inches of the ground line. At a height of not less than 6″ above the ground level a horizontal bed should be carefully prepared to receive a damp proof course. This course is usually inserted in the first joint above the ground, viz. on the top of the first course of face walling.

The same detail shows a brick and concrete foundation to the brick wall at the back elevation, and agrees in principles and application with earlier illustrations.

135. Ashlar quoins. We have previously described the meaning of the term "quoin" in connection with brickwork, see par. 29. It has the same meaning in masonry and the treatment of quoins in stonework often forms a special feature. We have pointed out that a quoin is one of the weak parts of a structure in brickwork owing to the amount of cutting necessary to obtain bond. In masonry this need not occur; larger blocks may be used as quoin stones, which, with sufficient lap in alternate directions along the faces of the wall, may transform an otherwise weakly tied mass into a strong and efficient quoin.

Detail No. 55 illustrates the use of "plain ashlar" quoins to coursed rubble walling, the quoins varying in length but lapping at *least* 3″ at every course in each direction.

136. Plinth. Below the mass of face walling, ashlar plinths are shown in detail No. 52, illustrating two methods of treatment.

Each plinth terminates with a moulded course, of which large details are given; an alternative section is shown on detail No. 57.

The sections indicate different widths of bed to successive courses in order to provide bond to the brick or stone backing.

137. Quoins at workshop gable. In detail No. 57 a special form of ashlar quoin is illustrated, where the quoin stones are channelled along their top edges to emphasise the joints and break up the large plain surfaces. The elevation and sectional plan show these stones clearly. It should be noted that the "channel" or "rebate" must be on the top edge of each block to avoid water being retained on the projection and absorbed into the joint.

Detail No. 56 gives the treatment of the stone dressings round the windows to the side of the workshop. The wall is constructed of regular coursed rubble on the face, and backed up with brick or random rubble stone as alternatively shown.

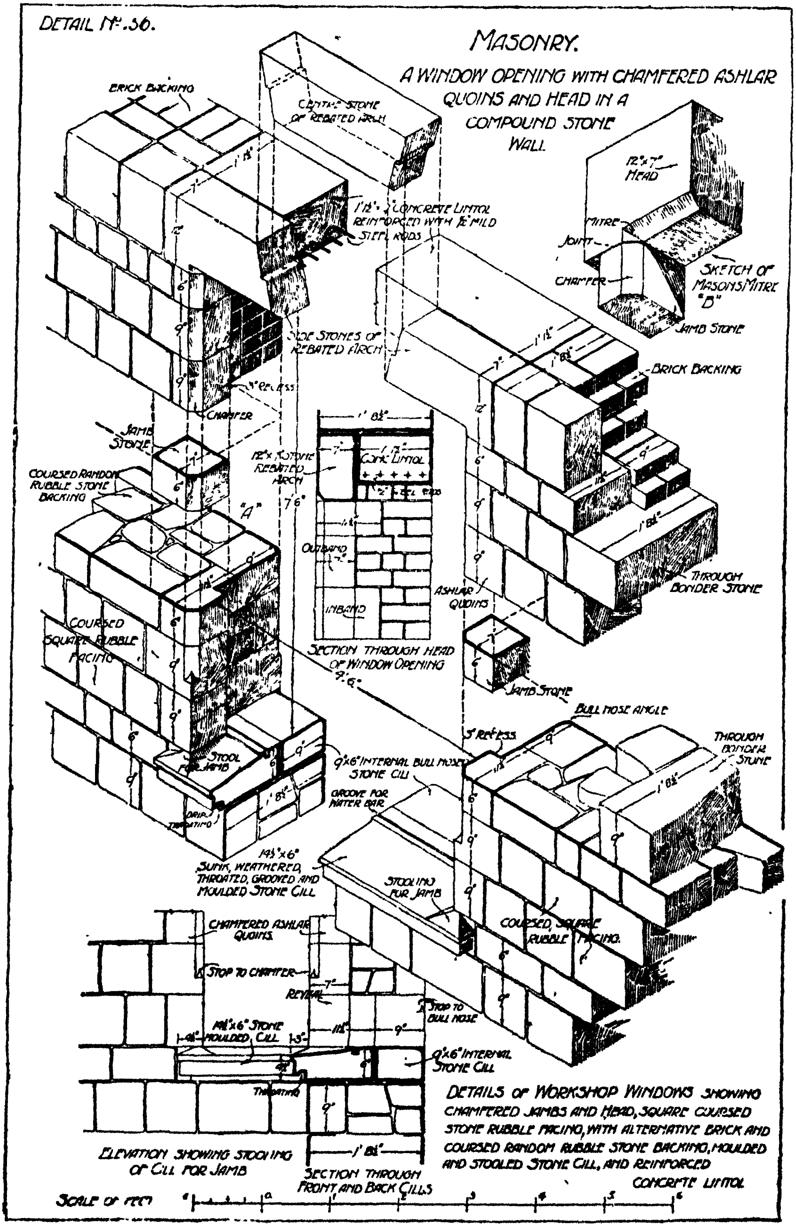
138. Lintol and cill. The treatment of lintol and cill is familiar from their application to brickwork. They vary only in size, due to a width of 7" being given to the reveals. A section through the head of the window is detailed, showing a chamfered stone "front lintol" and a reinforced concrete "back lintol."

139. Jambs. Observe the alternate bonders at the jambs which are purposely made of irregular lengths on the face.

The jambs are recessed 3" to receive the solid window frames (see Joinery) and when brick backing is used the width of the internal opening made suitable for brick bonding. If the compound wall has a stone backing as in detail No. 56 A, the dimensions are immaterial and the recess is often made 2" deep, with uniform dimensions of front opening.

140. Reveal bonders. The blocks of stone forming the jamb at each side of the opening are termed "dressings" and are really a form of "quoin." The dressings are alternately "recessed" and "straight," tying the face and return surfaces alternately. "Internal" quoins or dressings at the recessed part of the jamb are similarly arranged, and bonded by long and short stones alternately placed on each face. In all this work the minimum quoin lap should be 3" and all other parts at least 2".

141. Internal cill. An internal cill is provided to this opening, formed of one stone fitting *between* the jambs and rounded to a bull nose angle at the exposed edge. The reason for introducing the cill *between* the jambs is to make it perfectly independent of the mass of stonework on each side of the opening, and therefore unaffected


DETAIL No. 36.
MASONRY.
A WINDOW OPENING WITH CHAMFERED ASHLAR QUOINS AND HEAD IN A COMPOUND STONE WALL
BRICK BACKING
CENTRE STONE OF REBATED ARCH
1'1½" × 7" CONCRETE LINTOL REINFORCED WITH ⅝" MILD STEEL RODS
12" × 7" HEAD
MITRE
JOINT
CHAMFER
SKETCH OF MASONS MITRE "B"
JAMB STONE
SIDE STONES OF REBATED ARCH
BRICK BACKING
CHAMFER
JAMB STONE
COURSED RANDOM RUBBLE STONE BACKING
"A"
12" × 7" STONE REBATED ARCH
CONC. LINTOL
OUTBAND
INBAND
SECTION THROUGH HEAD OF WINDOW OPENING
ASHLAR QUOINS
THROUGH BONDER STONE
COURSED SQUARE RUBBLE FACING
JAMB STONE
BULL NOSE ANGLE
THROUGH BONDER STONE
STOOL FOR JAMB
9" × 6" INTERNAL BULL NOSE STONE CILL
GROOVE FOR WATER BAR
DRIP THROATING
14½" × 6" SUNK, WEATHERED, THROATED, GROOVED AND MOULDED STONE CILL
STOOLING FOR JAMB
COURSED SQUARE RUBBLE FACING.
CHAMFERED ASHLAR QUOINS
STOP TO CHAMFER
REVEAL
STOP TO BULL NOSE
14½" × 6" STONE MOULDED CILL
9" × 6" INTERNAL STONE CILL
THROATING
ELEVATION SHOWING STOOLING OF CILL FOR JAMB
SECTION THROUGH FRONT AND BACK CILLS
DETAILS OF WORKSHOP WINDOWS SHOWING CHAMFERED JAMBS AND HEAD, SQUARE COURSED STONE RUBBLE FACING, WITH ALTERNATIVE BRICK AND COURSED RANDOM RUBBLE STONE BACKING, MOULDED AND STOOLED STONE CILL, AND REINFORCED CONCRETE LINTOL
SCALE OF FEET

by settlement. It need not enter the jambs, such entry being the common way of treating an external cill to ensure weather-tightness.

142. External cill. This is of exactly the same *form* as a previous cill, but larger. The elevation shows its relationship to the reveal quoins, the necessary level "stool" for seating them upon and the weathering, sinking, throating and groove for the water bar.

Observe that in *section* the joint between the external and internal cills should be covered by the cill of the wooden window frame.

143. Head or lintol. The opening is spanned by a rebated stone arch, consisting of an odd number of blocks with radial joints and in two planes at each joint. The "rebate" or "check" in the joints prevents distortion in the case of slight settlement. The under edge on the face side is chamfered on the exterior angle like the reveal; the chamfers meet at the top corner and a "mitre" has to be formed. It is carved in the "solid" as shown in detail No. 56 B, and fits over the plain chamfer of the top dressing at the reveal. Such a mitre to a chamfer or moulding when cut in the solid, is known as a "mason's mitre," and is the only practicable method of constructing the intersection of mouldings in masonry and terra-cotta. The same form of mitre is often adopted in oak framing, being an imitation of the mason's mitre and always so named.

144. Dressings generally. Dressings are those pieces of worked or specially formed stone which are used to construct the exposed parts of the jamb at door, window and other openings in masonry walls. They should be accurately prepared with faces, beds, and joints mutually at right angles. It is wise to set them in fairly soft mortar in order to get close bedding and to avoid thick joints, and the greatest care is necessary to avoid mortar stains on the faces of the work. Black mortar, so common in many districts, is very liable to produce stains if allowed to exude and remain for a short time.

Spalled or broken edges are easily caused by careless handling and are irreparable; they must not occur.

145. Bed joints. In preparing bed joints for any of the foregoing work, workmen are liable to prepare the outer rim of a bed carefully and "true" to the width of a chisel draft round the edges, and then remove so much of the centre as to leave the bed hollow. This is the result of making too sure that the edges come together and give a "thin" joint. It causes a danger of "spalled" or "chipped" edges as shown in detail No. 66, due to the concentration of weight on the narrow rim before the mortar is sufficiently set. If a floor beam or lintol be placed near one edge and above such a block, the danger is increased; unduly hollow beds are not permissible. These do not occur when stones are sawn into blocks and the sawn face used at the joint.

146. Edge joints. A fault likely to occur in all stonework is to make the joints (particularly edge joints) bevel inwards from the face of the wall either to save material (which would have to be wasted if cut square) or to ensure a neat face joint. Beds are often so bevelled and packed up with stone chips or spalls at the back edge, giving a result equivalent to a hollow bed. Vertical edge joints are most likely to be at fault and all stones not reasonably squared for a distance of *at least* 2″ from the face should be required to be recut.

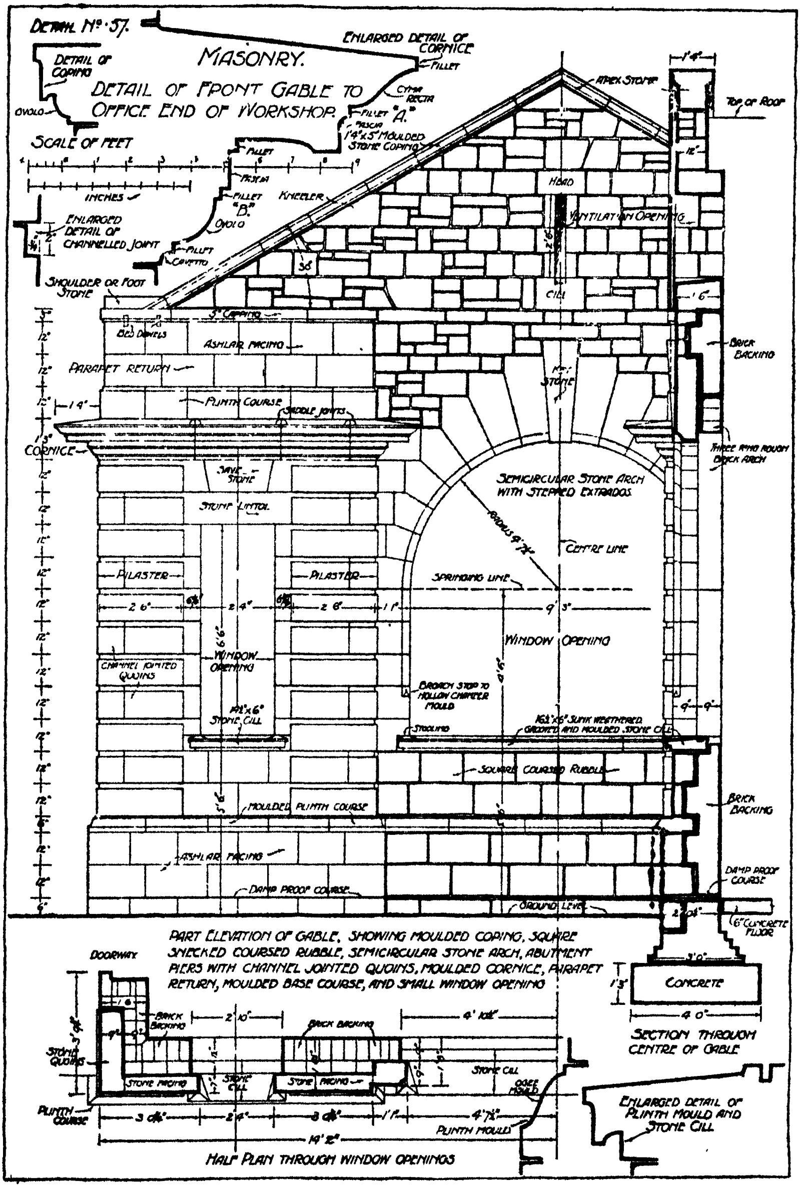
147. Detail of front gable. Detail No. 57 shows the full design for the front gable, which forms the office end of the workshop. It is designed to introduce various stonework details in a small area, yet quite in harmony with each other.

Three windows are required, viz. a large window to the office, a small window on the left to the entrance lobby and a third necessary to preserve symmetry of design on the right-hand side. A little over half the elevation is supplied and a vertical section through the centre of the "gable."

Gable. We should here note that a gable is that part of a vertical wall in a building which is continued to meet the cross section of a roof, or to guard and screen it while more or less maintaining its *form*; hence it is usually triangular in shape.

The general scheme of design allows for a deep plinth projecting 3″ from the main surface, with two masses of walling containing the side windows projecting 2½″ from the surface, having the plinth carried round it and "returned" for a short distance round the angle and along the back of the building. These containing masses are broken into two equal vertical strips, emphasised by courses of ashlar with channelled joints giving the appearance of two piers enclosing the window and crowned by a stone cornice. This is returned and stopped over the entrance doorway from yard and at the other end is carried round the angle and along the side of the building; see general drawings of workshop.

Above the cornice a solid stone fascia is formed with a base, dado, and capping course, the outer stone of which serves as a "gable shoulder" or "footstone" on which the "coping" abuts. In the centre of the gable and between the double pilasters is a large stone arch with chamfered reveals. The arch has "stepped voussoirs" gradually gaining in depth, arranged to suit the 12″ ashlar courses from the springing to the haunch, and to receive the snecked rubble courses filling up the gable from cornice to apex. The arch is "keyed" by a tapered keystone, not chamfered, but emphasised by treating it as a "projecting key," thus giving it greater prominence.


DETAIL No. 57.
MASONRY.
DETAIL OF FRONT GABLE TO OFFICE END OF WORKSHOP.
DETAIL OF COPING
OVOLO
SCALE OF FEET
INCHES
ENLARGED DETAIL OF CORNICE
FILLET
CYMA RECTA
FILLET "A."
FASCIA
1'4"x5" MOULDED STONE COPING
FILLET
FASCIA
FILLET
"B."
OVOLO
KNEELER
FILLET
CAVETTO
ENLARGED DETAIL OF CHANNELLED JOINT
SHOULDER OR FOOT STONE
APEX STONE
TOP OF ROOF
HEAD
VENTILATION OPENING
CILL
5" COPING
BED DOWELS
ASHLAR FACING
PARAPET RETURN
PLINTH COURSE
SADDLE JOINTS
CORNICE
SAVE STONE
STONE LINTOL
KEY STONE
BRICK BACKING
THREE RING ROUGH BRICK ARCH
SEMICIRCULAR STONE ARCH WITH STEPPED EXTRADOS
RADIUS 9'7½"
CENTRE LINE
PILASTER
PILASTER
SPRINGING LINE
WINDOW OPENING
WINDOW OPENING
CHANNEL JOINTED QUOINS
BROACH STOP TO HOLLOW CHAMFER MOULD
14"x6" STONE CILL
STOOLING
16½"x6" SUNK WEATHERED, GROOVED AND MOULDED STONE CILL
SQUARE COURSED RUBBLE
MOULDED PLINTH COURSE
BRICK BACKING
ASHLAR FACING
DAMP PROOF COURSE
DAMP PROOF COURSE
GROUND LEVEL
6" CONCRETE FLOOR
PART ELEVATION OF GABLE, SHOWING MOULDED COPING, SQUARE SNECKED COURSED RUBBLE, SEMICIRCULAR STONE ARCH, ABUTMENT PIERS WITH CHANNEL JOINTED QUOINS, MOULDED CORNICE, PARAPET RETURN, MOULDED BASE COURSE, AND SMALL WINDOW OPENING
DOORWAY
CONCRETE
SECTION THROUGH CENTRE OF GABLE
BRICK BACKING
BRICK BACKING
STONE QUOINS
STONE FACING
STONE CILL
STONE FACING
STONE CILL
OGEE MOULD
PLINTH COURSE
PLINTH MOULD
14' 2"
HALF PLAN THROUGH WINDOW OPENINGS
ENLARGED DETAIL OF PLINTH MOULD AND STONE CILL

A small ventilation opening is provided in the gable—fully detailed —and the whole slope of the gable is covered by a 5″ thick moulded coping, finished and bonded by an "apex stone" at the point of the gable and supported at an intermediate position in the length of the coping by a "kneeler" (see subsequent note).

148. Gable parapet. The gable is carried above the roof to form a "parapet" whose rise above the roof is 1′ 6″. On the right-hand side (not shown here) the base of the gable shoulder returns along the front of the building and forms the coping to the parapet wall which shields the gutter.

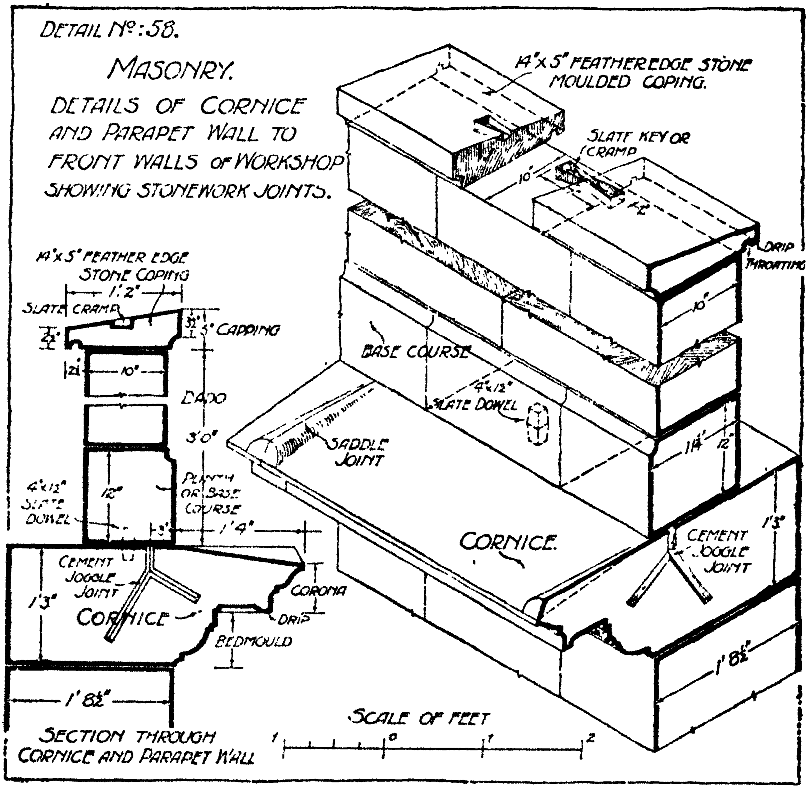
A parapet is a wall carried *above* the roof surface to shield the eaves or guard the verge of the slates. Observe that the main wall is 18″ thick while the parapet (see section) is 12″ thick.

149. Side windows. The openings for the side windows have square jambs and are bridged by stone lintols 12″ deep. Above each of these is placed a safeguard which consists of a wedge-shaped stone called a "save-stone"; its purpose is to relieve weight and save the lintol from displacement. The same principle may be applied to plain flat arches.

150. Cornice, parapet, etc. The cornice and parapet along the side wall agree with the same features at the gable and a cross section through these crowning courses is given in detail No. 58, showing the cornice, parapet, and coping. The cornice stones are large blocks, 3′ wide back to front and as long as may conveniently be obtained, worked and handled. Because of the large projection the cornice must be inserted ("tailed") well into the wall to balance it securely, and, if placed as detailed, would receive the wall plate and roof timbers on its top bed and consequently become heavily loaded and additionally secured. Where at all practicable, the "tailed in" end of the cornice should be in itself sufficient to balance the overhanging part; otherwise, temporary support has to be provided until the parapet is laid upon it.

151. Cement joggle. To prevent disturbance of these cornice stones at the joints, which may arise through slight settlement of parts of the structure and destroy the accuracy of its lines, a cement joggle is formed at the vertical joints by cutting a vee-shaped three-way groove in each joint face, arranged to "pair," and forming when assembled a square slot set diagonally in section. When the blocks have been laid, truly bedded, and flushed with mortar—except the three-way grooves—the joggle is made by pouring cement grout through the head of the vee. After setting, it resists movement of the stones in the direction of the joint, but could not prevent them pulling apart lengthwise.

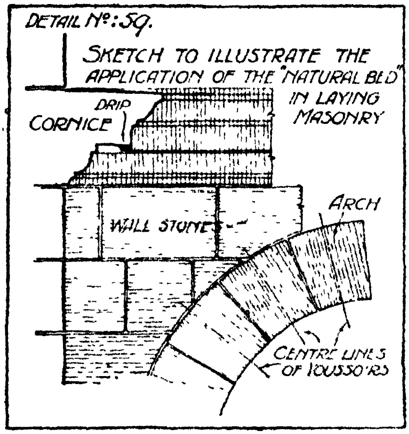
152. Weathering, and saddle joints. Every projecting and exposed surface must slope to get rid of water quickly, and for this purpose cornices are weathered like cills. However carefully these may be jointed vertically in mortar, the joints, through slight expansion and contraction, soon become unsound and water find its way through the joint. To avoid this, stone cornices are often covered with lead, or, as an alternative, a "saddled" joint is formed in the stone as shown in details Nos. 57 and 58. Each side of a joint retains



its horizontality at the top edge, but a rounded projection is left at the end, forming a "stop" to the weathering. The form of this is clearly semicircular across a section taken near and parallel to the face and provides a protecting ridge to the joint, allowing very little water to collect. The projections when brought together form a "saddleback" and the joint is termed a "saddled" or "horsed" joint.

To prevent its being prominently seen in elevation the front portion is bevelled backwards at 45°.

153. "Natural bed" in cornices, etc. Many building stones have clearly marked "planes of bedding" due to their being naturally formed in layers deposited upon each other in succession, and along which separation is easier than in any other direction. In most structures, where feasible, we should so place the blocks of stone that these planes of bedding are being pressed together, thus avoiding danger of separation which may occur through the action of frost, and sometimes by injudicious loading when unsuitably placed. Detail No. 59 shows how the natural layers (or "laminations") should be placed in "plain walling," in "arches" and in cornices which overhang a considerable distance and are "undercut." Observe that the laminations in arch voussoirs are at 90° to the face of the wall, with their "edges" occupying an average position "normal" to the curve of the arch. This occurs when the centre line of each voussoir is radial to the "arch centre."



Now suppose that the cornice detailed here had its natural layers horizontal, like the stones below it. Then the "drip" (shown in the section of detail No. 59) would be most vulnerable to the effects of wet and frost and liable to be quickly detached, as indicated in section. A similar process might also detach portions of the "bed" of the crowning members.

To avoid this effect the natural bed of such a cornice stone is wisely placed in vertical planes at right angles to the length of the cornice.

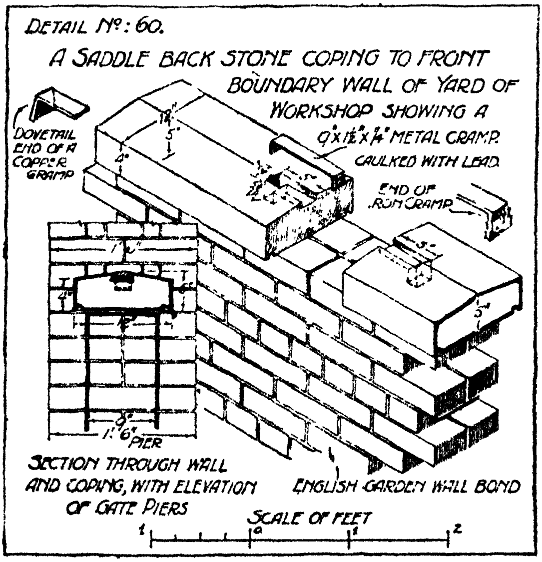
154. Parts of cornice. The cornice illustrated in detail No. 58 consists of two main portions, the "corona" or upper portion, and "bed mould" or lower and supporting portion. The corona is subdivided into other mouldings which vary considerably, some of which are named on the enlarged detail of No. 57 at A. Between the corona and bed mould the drip is formed by means of a sinking in the projecting bed of the corona. The bed mould may be made up of various members, suggestions for which are shown in detail No. 57 B.

155. Function of cornice. A cornice should effectually prevent rain water trickling down the face of the building below it. Correctly designed, while distinctly decorative, it should have a drip near the front edge with a margin at the drip 1" to 1¼" wide. In our detail

the drainage from the cornice drips 10″ clear of the wall, and the bed mould, in ordinary circumstances, never becomes wet.

Observe that no such projecting feature prevents driving rain from wetting the wall at a short distance below the cornice, but such rain is spread uniformly over the face and does not produce patchy stains or vertical lines of black and brown arising through constant trickling down one path, such as faulty joints and inequalities of dressing.

156. Parapet. We have previously referred to and explained the term parapet and detail No. 58 shows an ashlar "parapet" 3′ high, and 10″ thick, standing immediately above the cornice, hiding the lead gutter and providing balance weight to the cornice course. It consists



of three parts, viz. plinth, dado and capping, the names referring to architectural divisions of the parapet. Plinth has already been decribed. The "dado" is the area of plain work between the plinth and cap.

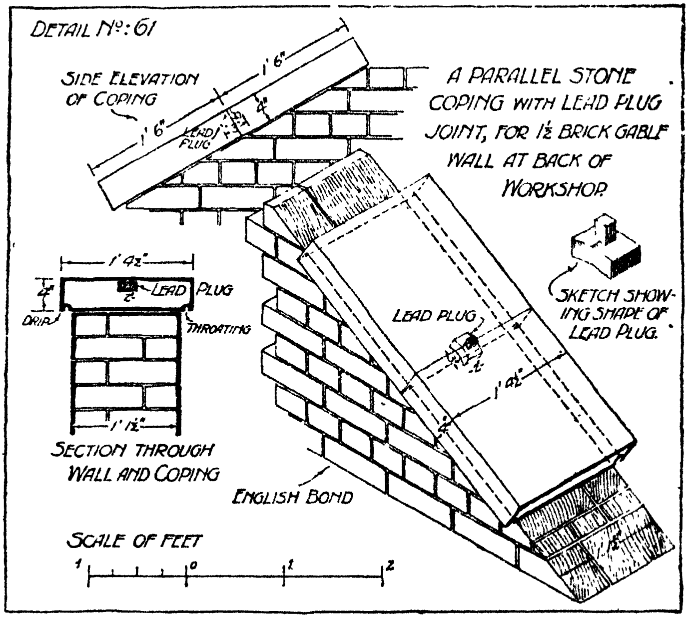
157. Weathered coping. The capping mould is provided by a "feather-edged" or "weathered" and moulded stone coping overhanging at back and front, and throated behind to drip into the gutter.

158. Slate key. The coping stones should always be secured to each other to prevent lifting or movement, which becomes possible by gusts of wind gripping the overhanging edges. Gusts are largely "local" and might lift and disturb one or two stones, but if secured end to end the danger is minimised. (Inequalities of settlement also cause slight displacements.) In detail No. 58 we show a "slate key"

for this purpose; it is of "double dovetail" form, set in portland cement and will prevent "side" and "longitudinal" movement. Other joints in use are the metal cramp and cement or lead plugs.

159. Metal cramp. The metal cramp, detail No. 60, is shown applied to a saddleback stone coping at the boundary wall of the workshop yard, but may be employed for connecting any pair of stones in copings, and similar units of stone.

It consists of a piece of wrought iron or copper, say 12" long, and $1\frac{1}{2}'' \times \frac{1}{4}''$, with the ends turned at right angles to the length and enlarged to a "dovetail" form. Copper cramps are "cast" (moulded)



and have smooth dovetail ends, while the W.I. cramps are bent at right angles or "bossed up" to a dovetail end and "ragged" by the blacksmith. Wrought iron cramps may be dipped in oil while hot, or galvanised to preserve them until used. They may be set in neat cement or run with molten lead or brimstone. In any case the cramp should be completely encased, leaving no metal subject to oxidation assisted by wet and exposure.

160. Lead plugs. These are formed by cutting pairs of dovetailed recesses in adjacent stones and providing a groove to run them solid with molten lead, as applied in detail No. 61 to the parallel stone coping of brick gable at the back of workshop. They are not strong nor in any way so reliable as the other methods illustrated.

161. Raking copings. We have previously defined and described a "coping." Raking copings serve the same purpose but are inclined to the horizontal, as necessary for covering the parapet of the gable. It is a matter of great importance that a coping to the continuation of a main wall shall be quite sound and weather proof; water must not percolate through the joints and reach the interior.

162. Coping joints at gable. The coping stones are necessarily in long lengths and the heading joints are the chief consideration. In steep gables—45° and over—they may be square jointed and set in cement without much danger of leakage, because the water gets off quickly, but in flatter pitches it is wise to ensure that each joint is watertight. Special methods of doing this will be considered in a later volume.

163. Coping supports and terminals. Copings to gables need support at the foot and also at intermediate points if the length of the gable slope exceeds 10 ft.

Detail No. 57 shows how this may be provided. At the foot of the slope is a stone which forms the outline of a "gable shoulder." (Shoulders are horizontal springings to rising surfaces.) The shoulder stone has a level bed and slightly weathered top surface, and its "coping end" is prepared to receive the square joint of the moulded coping and continue it to die out upon the horizontal continuation of the parapet coping, at the gable front.

164. Bed dowels. The shoulder stone is "dowelled" to the two stones on which it beds by two 1" square slate or copper dowels, 3" long. The object of this is to cause any thrust from the copings to be resisted by the combined weight of the shoulder stone and its supports, transmitted through the dowels.

165. Footstone. Details Nos. 104 and 183 show how this support may be provided when the coping is continued on the slope to the foot of a plain gable such as the brick gable to the back of the workshop. A part of the coping is worked upon a large block, mitred from the rake to the horizontal, well bonded into the wall and providing a square abutment for support of the line of coping. This springer is variously called a "footstone," "skew corbel," and "gable springer."

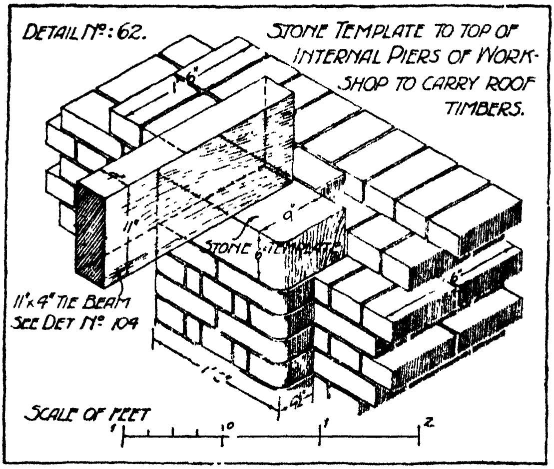
166. Kneeler. When the length of the gable is such that an intermediate support becomes necessary a bonding stone called a "kneeler" is inserted, which carries a piece of coping worked on the solid and prepared for jointing at both ends. The gable kneeler is shown on detail No. 57, this being "moulded" and sunk from the top face, while a plain kneeler for a similar position, prepared on the northern method, is shown at detail No. 104.

In this case the stone has its top joint "notched" instead of sunk and keeps out the water more efficiently, with less labour in its preparation. Its architectural appearance is, however, defective.

167. Apex stone. To finish the coping at the apex of the gable, because mitreing cannot be allowed, a solid block of stone is employed to continue the copings to their intersection. Various modes of ornamenting apex stones are employed, the opportunity provided for decoration being good and easy to utilise. Take note of churches and public buildings and you will observe many types of ornament and finish.

TEMPLATES

168. We shall have need to provide good bearing surfaces for roof beams to workshop and shed, because these transmit considerable loads to their supporting walls.



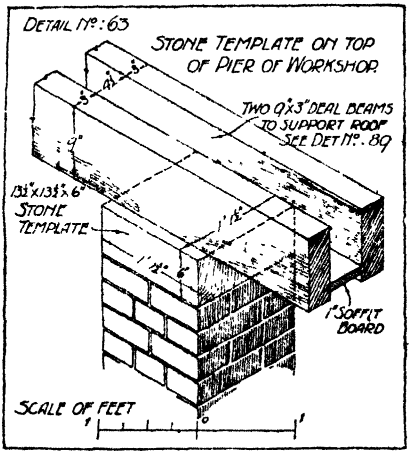
If allowed to rest upon the few bricks or small stones in general use for the mass of walling, an unsatisfactory distribution of the load would occur and probably some crushing of the joints immediately beneath. The load should be spread over as large an area as may be required to prevent the fracture or undue settlement of the work on which it rests.

A "template" is employed for this purpose and consists of a rigid piece of wood, stone, or metal of sufficient area to ensure uniform spreading of the load. (Wood templates should only be employed in temporary work.) Stone templates are the most common, made of a size suited to brick bonding.

For supporting our workshop roof timbers a stone 18″ long (width of attached pier) and 9″ wide × 6″ thick is sufficient—detail No. 62.

(If necessary it might have been made longer and wider and notched to form recessed angles at the sides of the pier.)

Reinforced slabs of concrete are good for irregular bearing areas, with the reinforcement of small rolled steel sections, *e.g.* T or I shape—see detail No. 181 A. *Steel templates* are employed in special cases (see later volumes of this work).

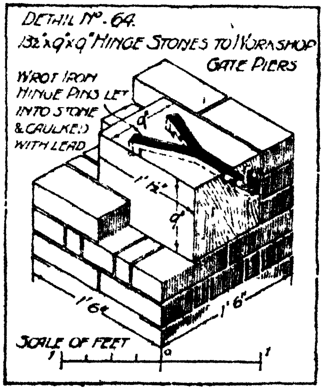


169. Pier templates. Detail No. 63 shows the square stone template necessary for finishing the brickwork and providing a bearing surface where the front beam of the shed roof crosses it.

170. Template and templet. Students should particularly note the possible confusion between the words "template" and "templet." A *template* is a bearer and load distributor. A *templet* is a pattern for guidance in shaping some constructive detail.

Hinge Stones

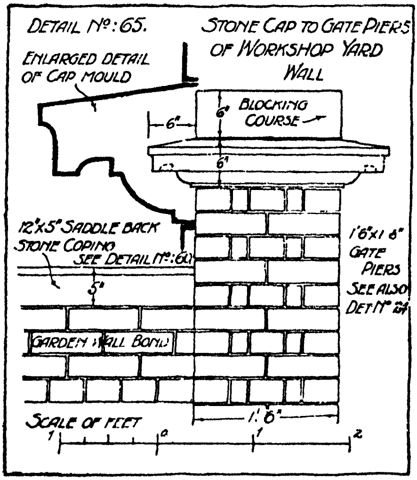
171. When external doors or gates have to be hung (pivoted) to brick or stone jambs and piers, without the intervention of wooden frames for this purpose, large stones are bonded into the brickwork or masonry to receive and support vertical pins welded to a projecting wrought iron bracket which is "anchored" to the stone. Detail No. 64 shows the method of forming and securing the "hinge pin"; the bracket is opened out to form two wings at the back, with downward projecting lugs of dovetailed form to resist the pull. The bracket is housed into the top bed of the hinge stone, housings are slightly bevelled and the whole secured by running with molten lead and caulking. To "caulk" is to make dense by hammering and wedging tight. "Run lead" is caulked with a steel tool having a narrow flat end like a blunt chisel, which is inserted in the joint and smartly tapped over the whole exposed area. This consolidates the lead, closes air



holes and fills the crevices where lead has not penetrated. Caulking must not be overdone or the lead is disturbed and loses cohesion.

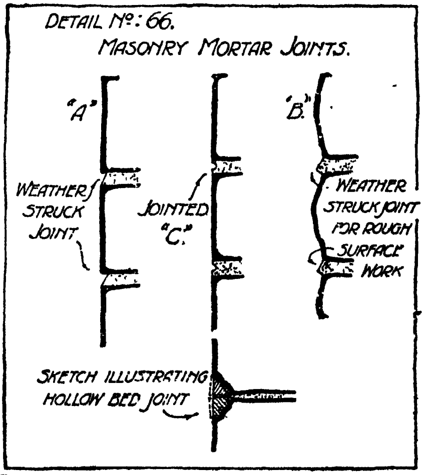
Hinge stones for heavier gates may be the full section of the gate pier, or even project and bond into the boundary wall beyond.

172. Gate pier caps. Gate piers require some form of coping or cap to "bind" the work below and preserve the interior against wet. For this purpose we have chosen a stone cap, weathered, moulded and throated and surmounted by a blocking course in the form of a square slab of stone. Each course is 6″ thick, the top stone being very slightly weathered, almost invisibly so. Detail No. 65 shows this together with an enlarged detail of the cap mould.



173. Mortar and bond. Bonding and bedding of stones in masonry should be very conscientiously attended to, because in roughly cut stones too small a lap leaves a considerable dependence upon the mortar. In any case the mortar should be first-class material, to assist the bond and make the thick joints of rubble walling watertight.

All joints need to be well trowelled during hardening or, in the case of thick face joints, it may be wiser to rake out the joints to a depth of $\frac{5}{8}''$ to $\frac{3}{4}''$ and "point" them by filling with "cement," or "lias lime" mortar.



174. Jointing. It is important to finish off the faces of mortar joints properly, in order to present a good appearance and throw off water satisfactorily from the joint.

Detail No. 66 shows three common forms suitable for masonry. Two of these are called "struck" joints and the other "jointed." (See also jointing of brickwork—detail No. 48.)

Struck joints have the mortar "cut" or "struck" off flush with the face, and then pressed and rubbed by the trowel "inwards" at the top edge. They must not be bevelled the other way or water is led into the joints.

"A," is the common and proper form of struck joint used during building and executed from the face of the work.

"B," is a method sometimes used for "rough surface" work such as "rock faced" walling and is also common in the North of England for finishing external pointing. It is known as a "weather struck" joint.

Jointed joints are "ornamented" flush joints. They are cut flush, pressed with the point of the trowel or a flat piece of bent iron, then grooved by running a bent "jointing iron" with a semicircular edge $\frac{1}{16}''$ to $\frac{1}{8}''$ thick along the centre of the joint. Its pressure consolidates the mortar, and the method gives the opportunity of making a wavy or irregular joint appear straight. "C" shows the common form of jointing. In very thick joints two lines of groove are adopted, near the beds of the courses respectively.

CHAPTER SEVEN

CARPENTRY

Introduction

175. Before entering upon a consideration of carpentry detail, it will be wise to point out briefly the essential differences between "carpentry" and "joinery."

Carpentry includes all timber construction whose primary intention is "strength." Thus, structures or their parts which are called upon to carry load or to resist pressure producing considerable stresses are "carpentry" structures no matter what the type or class of "finish" to the surface may be, nor whether the work be "temporary" or "permanent."

Joinery is distinguished from carpentry by the character of the woodwork it refers to. The term is applied to all the fittings, finishings and their provision for fixing, whose primary object is to increase the comfort and meet the convenience of the occupants of a building.

In carpentry we should include centering, timbering to support excavations, lintols, girders, wooden floors, roof-framing and partitions.

In joinery we should include window frames and sashes, doors and frames, plinths, or skirtings, linings, architraves and grounds, cupboards and stairs, all of which are dealt with in this volume.

Temporary Carpentry

176. Temporary carpentry is that portion of timber framework which is necessary in the execution of other constructional work but does not form a permanent part of the completed building. In our two buildings it includes timbering for excavations and centering for arches.

177. Timbering for excavations. We have not described excavations previously, having reserved the deseription for inclusion with the timbering, so far as this is necessary for our purpose.

An excavation is a "ground cutting" for the purpose of inserting the foundations and foundation walling of a structure, for laying a drain, or the provision of a basement. In this consideration we shall conceive the applications as timbering to cuttings for foundation trenches to external walls.

Most of our foundations are fairly shallow and with good firm ground may require no support to the sides, but we must be prepared

to cut them deeper if necessary in order to base the artificial foundation upon a suitable bed.

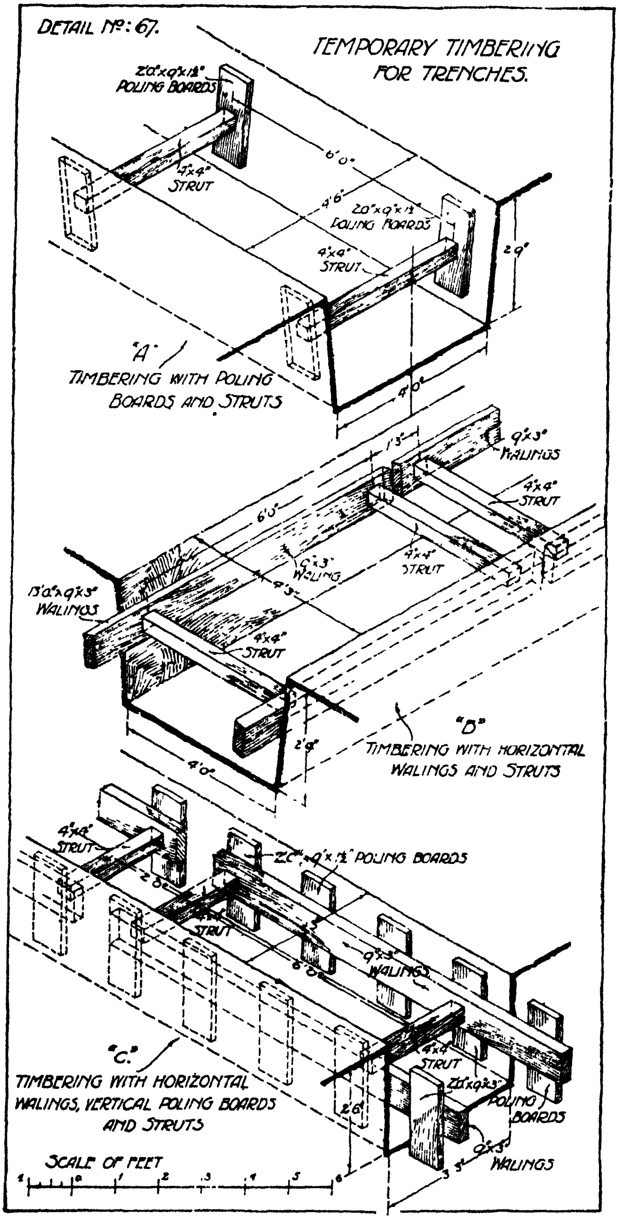
Hence the forms of timbering given in detail No. 67 must be conceived as satisfactory for certain kinds of soil and of greater depth, if required.

178. Firm ground. When the earth to be excavated is dry and firm it may stand for a considerable time without support, but if the excavation be continued to a depth of 3 to 6 ft., with softer patches occurring here and there, the excavator may judge it necessary to provide some support to avoid risk of collapse. The simplest method of doing this is to place pairs of 9″ × 1½″ "poling boards" from 2 to 3 ft. long, vertically opposite at the sides of the trench and to drive a 4″ square or round "strut" in a horizontal position to keep them apart. Sometimes two struts are necessary. The sides of the excavation are cut with a slight "batter" inwards so that struts do not work loose. Struts should not be driven too tightly in these isolated supports or the consolidated ground at the sides of the trench may become fractured and disturbed. Detail No. 67 A shows this elementary provision, the groups of timbers being placed about 6 ft. centres.

179. Rather loose ground. If the ground be uncertain, rather loose in places but not "soft," horizontal pieces called "walings," 9″ × 2″ to 9″ × 3″ and of a length up to 13 ft., are placed on opposite sides of the trench and strutted at approximately 6 ft. intervals. The support is now continuous, and concentrated at such depth in the trench as considered necessary. If deeper than 3 ft. two or more rows of walings may be required; they are added as the work proceeds. Detail No. 67 B.

180. Soft ground. When ground would obviously detach and slide down into the excavation in triangular masses, it must be supported continuously, though not necessarily "closely," and more continuity is desirable in a vertical direction—see detail No. 67 C.

Three sets of timbers are necessary here, viz. vertical "poling boards," secured by "waling pieces" which are held apart by "struts." The poling boards, 9″ × 1½″, are placed in position in pairs at about 2 ft. centres and strutted lightly apart until the number which may be supported by one length of waling has been placed. The first struts are placed below the centre of the poling boards; this allows a waling to be lowered into position on each side and struts driven between at 5 to 6 ft. intervals; the top struts are removed and any loose poling boards secured by vertical wedges driven between the poling board and waling piece. Walings for this purpose must be rigid, say 9″ × 3″ to 9″ × 4″.


DETAIL Nº: 67.
TEMPORARY TIMBERING FOR TRENCHES.
2'0"x9"x1½" POLING BOARDS
4"x4" STRUT
6'0"
4'6"
2'9"
4'0"
"A"
TIMBERING WITH POLING BOARDS AND STRUTS
1'3"
9"x3" WALINGS
4"x4" STRUT
6'0"
13'0"x9"x3" WALINGS
9'3"
2'9"
4'0"
"B"
TIMBERING WITH HORIZONTAL WALINGS AND STRUTS
2'0"x9"x1½" POLING BOARDS
9"x3" WALINGS
2'6"
6'0"
"C"
TIMBERING WITH HORIZONTAL WALINGS, VERTICAL POLING BOARDS AND STRUTS
POLING BOARDS
9"x3" WALINGS
SCALE OF FEET

181. Very soft ground. To accommodate very soft ground the vertical boards may be spaced to suit the conditions, brought close together if necessary, used in longer lengths and forced downwards as the excavation proceeds.

Deep and wide excavations and cuttings in bad soil must be left for more advanced treatment.

CENTERING

182. When a structure is to be erected which cannot support itself until "complete" and "set," it requires some "temporary support"; this support, whatever its nature, is *commonly known as "centering."*

The term has been widely applied to all kinds of temporary support including flat and curved arches, concrete floor and roof slabs, joggled lintols, domes and other ornamental work.

We shall restrict the term "center" to imply that kind of temporary support used in the erection of structures built of isolated blocks, which are more or less capable of retaining their position immediately they are completed. All true arches are of this class.

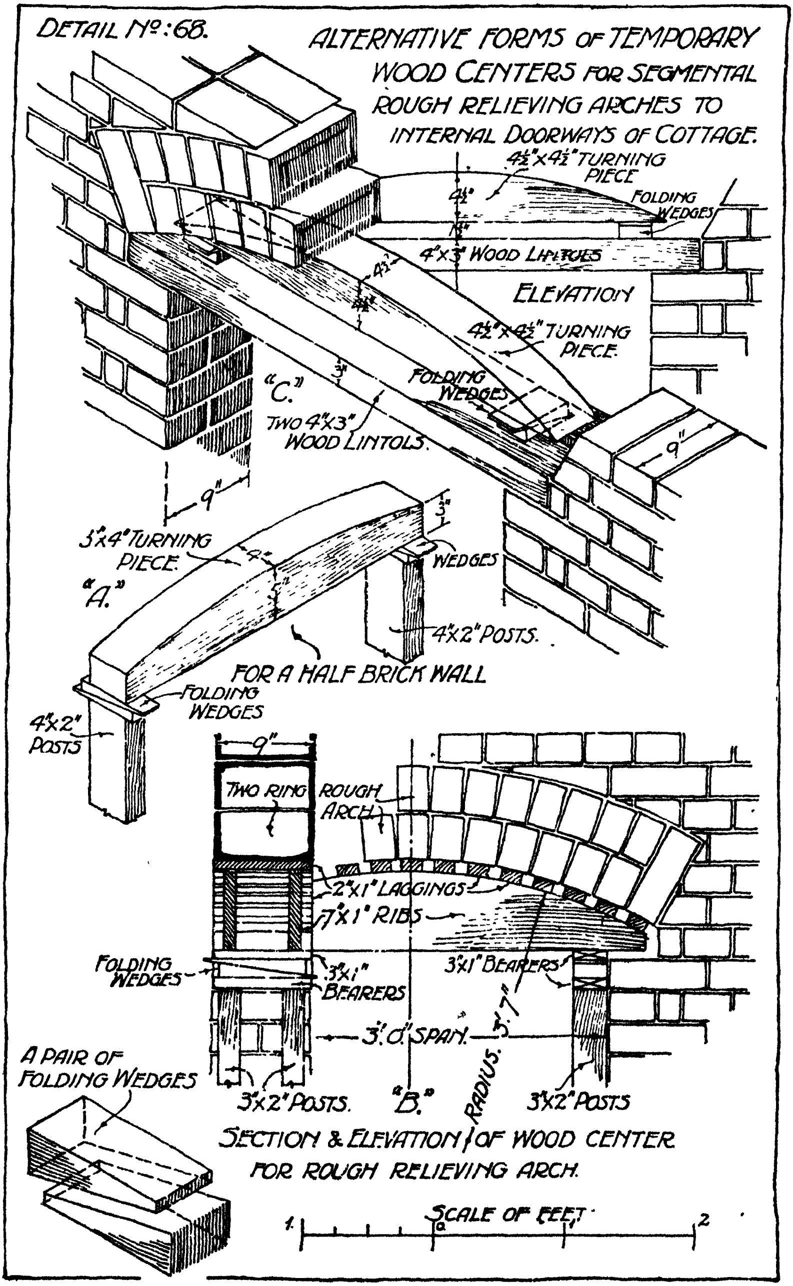
Temporary supports to concrete work in floors, lintols, roofs, etc., we shall term "shuttering."

A *center* is an erection, usually of timber framing and covering, upon which arch voussoirs are laid to the required curve, and which provides for easy withdrawal of the support—either wholly or partially—when the voussoirs are finally keyed in position. A center may be a single piece of curved wood, or it may be built up from comparatively small pieces.

183. Turning pieces. If a "single member" it is known as a "turning piece," this term being almost exclusively used.

Turning pieces are used for "flat" and "small rise segmental" arches whose "length" is $4\frac{1}{2}''$, a $4''$ piece of stuff being cut to the necessary curve as in detail No. 68 at A. A turning piece is therefore all that is necessary for the whole of the face arches of the cottage (except the front doorway which is semicircular in outline), although light centers are occasionally constructed for standard spans as in detail No. 68 at B, providing for repeated use. In either case observe that the bearing surface is continuously curved, and suitable for supporting a piece of accurately cut work while setting.

The light center shown in detail No. 69 at A consists of two $8'' \times 1''$ "ribs," $2''$ apart, with $2'' \times 1''$ cross "laggings" nailed to the ribs. A $3'' \times 1''$ bearing piece connects the ribs on the under edges and forms a supporting surface. All laggings should be kept back $\frac{1}{4}''$ from the face of the arch to prevent obstruction in building and *testing.*


DETAIL No: 68.
ALTERNATIVE FORMS OF TEMPORARY WOOD CENTERS FOR SEGMENTAL ROUGH RELIEVING ARCHES TO INTERNAL DOORWAYS OF COTTAGE.
4½"x4½" TURNING PIECE
FOLDING WEDGES
4"x3" WOOD LINTOLS
ELEVATION
4½"x4½" TURNING PIECE.
"C."
FOLDING WEDGES
TWO 4"x3" WOOD LINTOLS.
9"
3"x4" TURNING PIECE.
"A."
WEDGES
4"x2" POSTS.
FOR A HALF BRICK WALL
FOLDING WEDGES
4"x2" POSTS
TWO RING ROUGH ARCH
2"x1" LAGGINGS
7"x1" RIBS
FOLDING WEDGES
3"x1" BEARERS
3"x1" BEARERS
3'.0" SPAN.
RADIUS. 3'.7"
A PAIR OF FOLDING WEDGES
3"x2" POSTS.
"B."
3"x2" POSTS
SECTION & ELEVATION OF WOOD CENTER FOR ROUGH RELIEVING ARCH.
SCALE OF FEET
1 0 1 2

184. Supports. When an arch is set in soft mortar and work continued above it, the load gradually increases and tends to induce settlement and compression of the mortar joints.

If this cannot take place *freely*—as would be the case if the voussoirs were resting upon the center—when the mortar has set and the center is removed, the joints are not solid and irregular settlement is likely to occur. Hence all arches in first class work have the weight eased down upon the joints soon after the "key" is placed by slightly lowering the center vertically.

The correct condition is, that the center supplies little or no up-thrust but is ready to receive the mass if failure should accidentally occur. The process of slightly withdrawing the support is called "easing" the center, and is accomplished by using pairs of folding wedges (see details Nos. 68 and 69) which are placed between the center and its supports, with the "points" protruding, so that when tapped at the two points the center or turning piece drops. "Striking" a center is entirely removing the support.

In arches of small span, adjustment of centers in common work is often considered unnecessary, and *if laid in quick setting mortar* we must agree that wedges are not indispensable. With slow setting mortar they ought to be used, and this kind of setting is best except for "rough" arches as it allows the arch to adjust itself to the load and is better than a perfectly rigid structure.

The supports may be of *any material or arrangement suited to the purpose*, though wooden supports are most common, and some of these, such as are used in cheap domestic work, are referred to in the chapters on Brickwork.

The standard method of support for a turning piece is to use two flat uprights placed close to the jambs; let these rest on the cill and strut them apart a little below the centre of the opening, by a piece cut tightly between the jambs like an excavation strut. Striking wedges and turning pieces are then laid in position, and, to prevent side movement, lightly wedged endwise against the jamb.

185. Supports to ribbed centers. These are often posts, of square or approximately square section, resting on short bearers placed at the foot of the opening. With a short soffit single posts suffice on each side and are strutted apart as described above. As an alternative a 4" to 7" wide bearer may be placed across the cill of the opening, between the jambs, and the uprights cut to stand upon them; they may lean slightly against the jamb and should be spiked to the bearer at the foot.

All supports need to be rigid and must be secured without damage to or disturbance of the surrounding work.

186. *Centers to relieving arches.* We have already referred to some methods of building relieving arches. One very good and economical method of support during construction is illustrated in detail No. 68 at C. It consists of placing the wood lintol in position, and supporting a turning piece from the lintol upon pairs of folding wedges.

The voussoirs are then laid and the turning piece lowered on completion by easing the wedges. When set, the wedges are removed and the turning piece withdrawn.

Another method, equally good but less convenient and more expensive, is to omit the wood lintol in the primary work, place a center in position as shown at detail No. 68 B with 2″ × 1″ laggings 1″ apart (suited to a rough arch) and set the bearers close against the jamb and therefore short of the ends of the ribs, which must overhang into the recess for the wood lintol.

The arch is constructed, center eased, work allowed to set and the centering removed; then the wood lintol may be inserted and the core filled in, leaving the arch to do the work of support. We recommend the method of supporting from the lintol described above which requires "turning pieces" only, and does not obstruct the opening. This method is particularly suited to the building of internal relieving arches, which are faced with external gauged arches or stone lintols.

187. Semicircular centers with built-up ribs. Flat segmental centers may have their ribs cut out of single pieces of stuff as in details Nos. 68 at B and 69 at A, but semicircular centers and those with considerable rise have their ribs "built-up" by cutting separate "chordal pieces" or "segments," two or more in number, to make up the curve, and binding these with "cross ties," clench nailed to the segments. The feet of the "rib segments" are fixed with a 4″ × 1″ "longitudinal tie" to prevent spreading under load. In this case, detail No. 69 at B, the segments are cut from 9″ × 1″ material, and the cross tie from 7″ × 1″. These sizes depend on the dimensions of the center, but nothing wider than 11″ is easily obtainable; whatever width of stuff is employed the minimum width of the segments at the joints is desirably 4″.

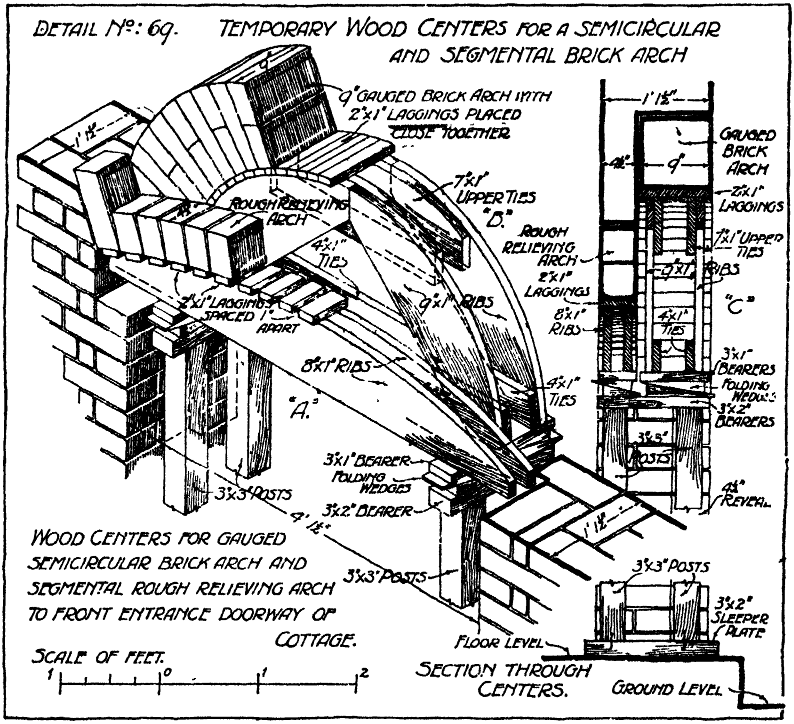
188. Terms employed in built-up centers. The "center" is the complete curved drum upon which the voussoirs rest, and has the following subsidiary parts:

Ribs, the vertical shaped frames, made rigid with struts where required, upon which the covering rests. Two ribs at least are necessary and if lightly built should not be further than 2′ 6″ apart.

Lagging, the covering of boards or bars upon which the soffit of the arch rests during construction. Its size depends on the length

of its "span" and varies from 2" × 1" to 3" × 1½" in arch building of moderate dimensions. The pieces may be openly spaced for rough brick arches, but are laid closely and shaped to the curve for "gauged" arches.

Bearers, also called "runners." There are two of these; one rests upon the supporting posts and receives the wedges, the other bears upon the wedges and receives the ribs of the center.



189. Cottage doorway. Detail No. 69 at C (section through centre of doorway) shows that two separate centers are required, *one* to support the semicircular face opening and the other for the relieving arch behind. The face arch is 9" and the back arch 4½" long. Detail No. 69 at A and B illustrates the separate centers required, which may be assembled on one set of supports as shown, with two pairs of adjusting wedges at each jamb.

Remember that the herring-bone filling to the tympanum of the front doorway does not interfere with the centering, because the filling is set upon the head of the door frame to be subsequently fixed.

190. Setting out centers. The "setting out" of centers and fixing of laggings, though provided in rough timber, must be carefully and accurately carried out.

To test the accuracy of the face curve (intrados) of an arch, while "setting" it, a "radius rod" pivoted on the tie of the center and cut to the nett radius is supplied. The center is placed so that its lag ends are *slightly within the face of the arch, leaving the voussoirs projecting sufficiently for testing.*

The student should give careful attention to practical instances of these temporary structures. He will find that differences in arch design, material to hand, and other matters, cause considerable variation in their detail.

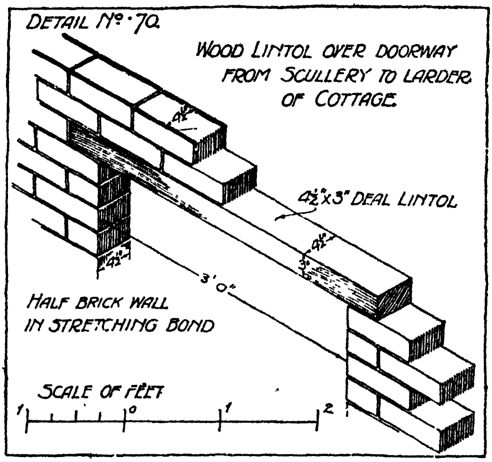
CHAPTER EIGHT

PERMANENT CARPENTRY

Lintols and Floors

In this section we shall consider the provision of lintols, bearers and timber girders, and the construction of floors, roofs and partitions as required for the cottage and workshop.

191. Lintols. Wood lintols are used to span window and door openings, and may serve to carry "part" or the "whole load" from the walling above, in addition to providing a convenient medium for fixing wooden frames within the opening.



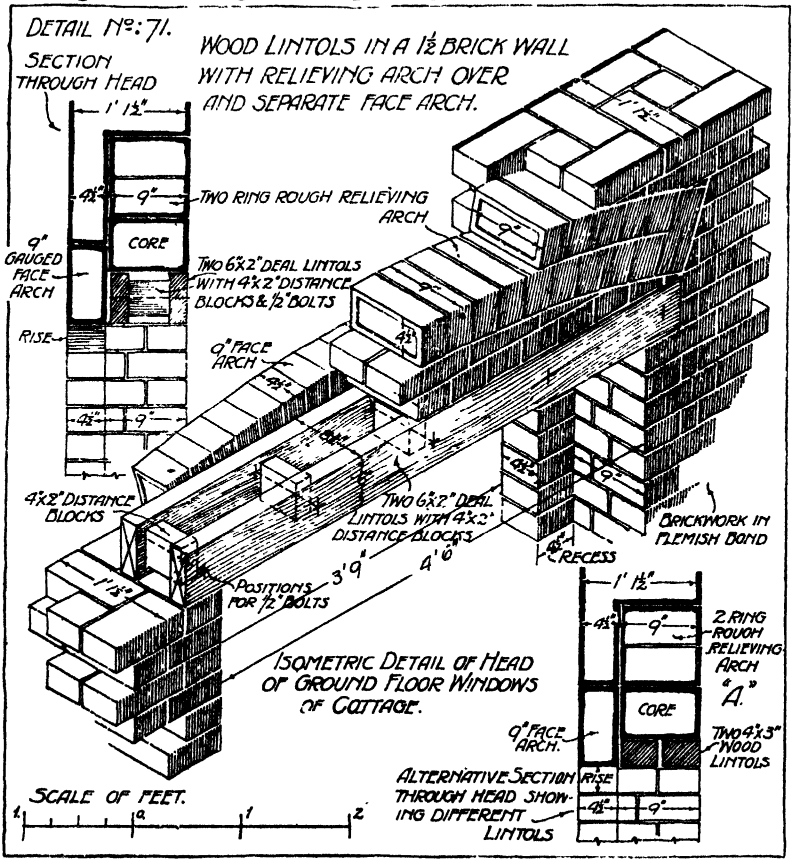
We have previously noted their application to external walls for supporting the "backing" of the wall above an opening, and also their use for internal door openings. In each case they were associated with "relieving arches."

Wood lintols to half-brick walls are conveniently 4″ × 3″ laid flat; this allows the wood to keep slightly within the plane of the brickwork, which is generally an advantage. Other sizes—commonly 4½″ × 3″—are employed wherever the conditions require a change —see detail No. 70. The minimum "bearing" of a lintol is 4½″ long, the bearing being the surface resting upon a support.

For spans up to 4 ft., 4″ × 3″ lintols are suitable if relieved, and one piece of material should be used for each half-brick in the

thickness of the wall; thus, a 9″ wall requires two, and a 13½″ wall three lintols, these being placed side by side with ⅜″ or ½″ spaces between, as in detail No. 71 at A.

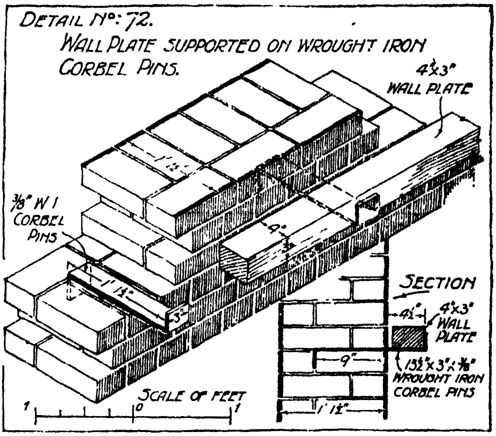
192. Built up lintols. Larger spans require deeper lintols and these become most effective and economical when built up of two or more pieces "on edge," with packings between and bolted together



as in detail No. 71. In the North of England it is common to make these lintols strong enough to carry all superimposed load and dispense with relieving arches; see chapters on Brickwork, page 55. In our case the lintol is of light construction because a relieving arch is erected over it, but it is rigid enough to prevent any possibility of sagging. The packings are 4½″ × 3″ placed endwise, spiked lightly to keep them in position, then drilled for ½″ bolts and secured firmly by nuts and washers. The slabs (or flitches) forming the lintol are

here 6″ × 2″, but they may be of any suitable sizes with a maximum of 11″ × 4″. An application in larger material than the lintol illustration is given in the chapter on Roofing, page 134.

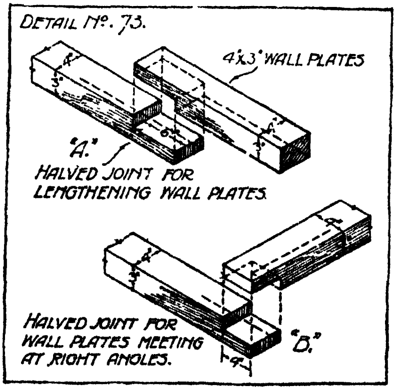
193. Wall plates. Where floor and roof timbers are to bear upon walls, or upon corbels and offsets provided for this purpose, bearing



timbers are often used to distribute the weight of the structure as uniformly as possible, and to provide for the timbers to be satisfactorily levelled and secured.

We have illustrated these in several previous brick details.

194. W. I. corbel pins. Should a wall plate be required to stand clear of a wall, and corbel courses are inconvenient or undesirable, the plate may be supported on corbel pins or brackets, of 3″ × ⅜″ wrought iron, shaped for support and anchorage, as shown in detail No. 72. They are commonly 2′ to 2½′ apart and in this instance are 1′ 1½″ long and turned 2″ at right angles at the ends.



195. Joints in plates. Joints in the length of wall plates should be as few as possible and disallowed in any length less than 12 ft. If jointed, a half-lap scarf 6″ long should be employed and securely nailed—detail No. 73 at A.

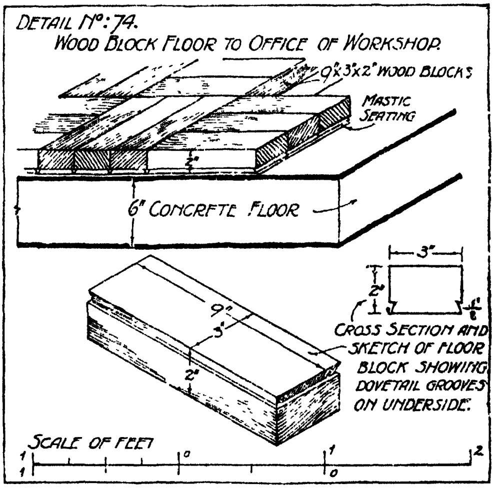
Similar half-laps should be used for right-angled and other intersections as shown in detail No. 73 at B.

Position for joint should be chosen to give a solid bearing to the plate underneath it, or in the case of "corbel pins" a support placed at each side of the joint. The function of these joints is to prevent "pulling apart" lengthwise and two small bolts are therefore better employed than nails in securing the joints. The halvings may be bevelled to assist in preventing separation of the joints.

Floors

Wooden floor surfaces may be constructed for basement and ground floors by laying blocks of wood upon concrete.

196. Office floor. This method of finishing a floor surface is usefully applied to the office of our workshop and in some probable



uses of the structure the whole floor might be finished with wood blocks. The office floor is prepared to finish at the same level as that of the workshop,—the concrete rising to different levels in order to lay 9″ × 3″ × 2″ wood blocks of northern pine in position on a hot layer of bituminous mastic. The edges of the blocks are bevel rebated, so that when assembled they form a dovetail groove into which the mastic rises and keys them into position; the mastic should not rise into the joint, which would prevent close fitting of the blocks. In our case they are laid in squares of three blocks, alternating in direction as shown in detail No. 74. Other patterns will naturally suggest themselves to you which would be equally suitable. Concrete upon which wooden blocks are laid must be quite dry, rendered level with 1 to 2 mortar of portland cement and sand, and the hot mastic brushed on in small patches which may be covered before setting.

"Boarded" ground floors are sometimes laid on dovetailed bearers embedded in the concrete and again by nailing boards directly to "breeze concrete." Applications of these are deferred to a later volume.

197. Ground floors of joists and boards. Ground floors of houses, where the floor is raised above the earth, generally consist of light joists laid across short spans and covered with boards.

"Joists" are the timbers supporting the covering of a floor. (Metal bearers serving a similar purpose are also called joists.) Wooden joists vary in size from 4″ × 2″ to 11″ × 4″, the larger dimensions being employed for special cases only.

"Boards" are thin slabs of wood laid upon the joists at right angles, and from 1″ to 1½″ nominal thickness. The span of a 1″ board should not exceed 12″.

"Span" is the clear distance between the supports, measured in the direction of the length of a board or joist.

When joists have to be arranged to surround openings or other obstacles, they have to be cut and jointed together. They are then said to be "trimmed." We shall deal with this in detail as it arises in our examples.

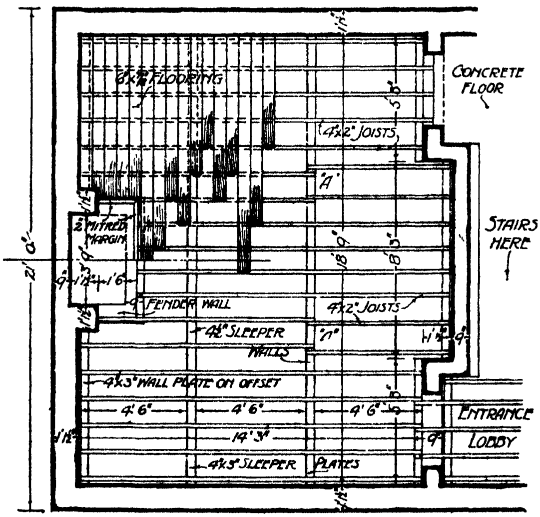
198. Ground floor of cottage. The ground floor of our cottage is a good example of the general method of treating ground floors. Light joists are laid in whichever direction is most convenient, viz. parallel, or at 90° to the chimney breast, and divided into spans of 4′ 6″ to 6′ by the use of intermediate supports. This forms the simplest kind of single floor (see detail No. 75). Observe that if the joists were made to span the whole room large timbers, at least 9″ × 2″, would be necessary; but light joists, say 4″ × 2″, are very much stronger and stiffer over a 4′ 6″ span than 9″ × 2″ over a 14′ span, hence two intermediate supports in the form of "honeycombed sleeper walls" are laid on the concrete parallel to the chimney breast and provided with a "sleeper plate" for bearing. The joist ends are carried on "offsets" at the external and division walls, and upon the "fender wall" in front of the fireplace; see detail No. 49, page 76.

No trimming of any kind is necessary; this makes for economy and strength. Observe further that the spacing of the joists works out at a little over 11″, keeping within the 12″ stated to be allowable.

199. Wall joists. Joists adjacent to a wall should not be more than 2″ distant therefrom, except where unavoidable, nor should they touch the wall.

200. Spacing of joists for irregular plans. In our example, detail No. 75, notice that uniform spacing of the joists right across the floor would result in the two joists nearest the ends of the recess opposite the fireplace being too far away from the short piece of wall. We have therefore placed the two end joists within the recess in two lengths, lapping them on the sleeper wall as at AA in this detail, and spreading them out to fill the space. In such cases it may be necessary to allow a slight excess over the 12″ clear spacing prescribed; if exception be taken to this, an additional joist is inserted.

DETAIL No: 75. SINGLE FLOORS.



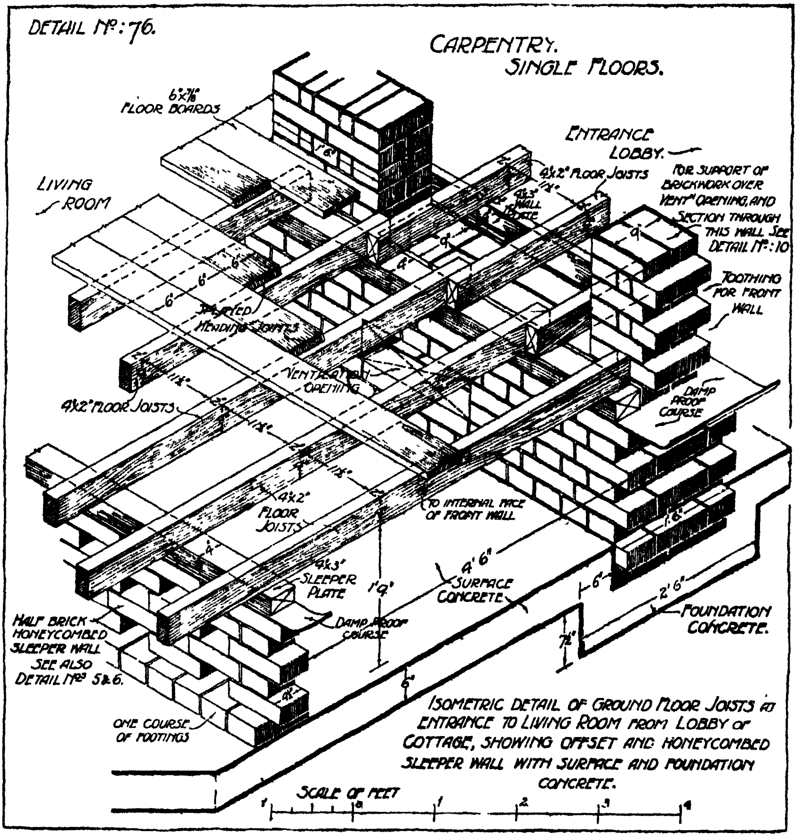
PLAN OF LIVING ROOM OF COTTAGE SHOWING ARRANGEMENT OF FLOOR JOISTS SUPPORTED UPON WALL PLATES ON OFFSETS AND SLEEPER WALLS.

SCALE OF FEET

201. Lobby floor. Refer to the isometric drawings of detail No. 76 representing the joisting of the lobby. The joists have to pass through the doorway and therefore rest on *both* plates, lapping the longer joists by 4″. The arrangement of these timbers is a matter of convenience. Should the joists at the sides of such a doorway leave too large a space for overhanging boards to be satisfactorily borne, a short length of joist stuff would be laid across the doorway only, close to the jamb, to which the board ends may be nailed.

202. Damp situations. In situations known to have been initially damp, although precautions have been taken to keep the joists dry,

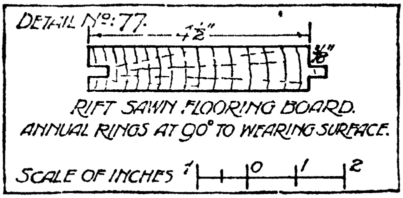
there is always a possibility of the air being too humid, of damp penetrating and decay commencing. It is therefore wise to brush over all surfaces and ends of joists including the under side of flooring boards with some preservative such as preparations of creosote applied hot, two coats being necessary for adequate treatment.



203. Flooring boards. Our illustration detail No. 76 shows 6" × 1" flooring boards with "square edges," which are still in common use. They possess the advantage of "little waste," "long wear" and "easy laying," but against these must be placed the disadvantages occasioned by "their edges being free to curl" (warping), thus destroying the "planeness" of the surface, and the open joints caused by shrinkage which renders *ground* floors draughty and detrimental to health unless completely covered with linoleum.

The boards are nominally 1″ thick by 6″ wide, but after machining to the finished condition they measure about ⅞″ thick and 5⅞″ wide, and students should bear in mind that all "wrought" material, though probably referred to by its initial sizes, is reduced by at least ⅛″ in each linear dimension when wrought on all faces, while "unwrought" material (left as sawn) is often somewhat larger than the nominal size.

When square edged boards are used, they must be of well-seasoned material and are wisely sawn so that the annual rings are almost vertical when the boards are laid in position. This reduces the possibility of shrinkage and warping (curling) to a minimum.



Detail No. 77 shows the best disposition of the grain in a flooring board, so far as shrinking and warping are concerned.

204. Folding and cramping flooring boards. Square edged flooring boards must be tightly laid joint to joint, which may be executed by "folding" or "cramping." *Folding* consists of securing two boards upon the joists, parallel to each other and having a space between them slightly less than the width of three or four boards; the space is then filled by placing the group of boards edge to edge between them, and forcing into place by the workman standing upon other timbers laid across them.

Cramping consists of forcing the boards tightly edge to edge by "screw cramps" clipped over the joist edges, the pressure being applied through a stout piece of wood bearing upon the edge of the last laid board. Five or six boards are cramped at one time and nailed near each edge to each joist.

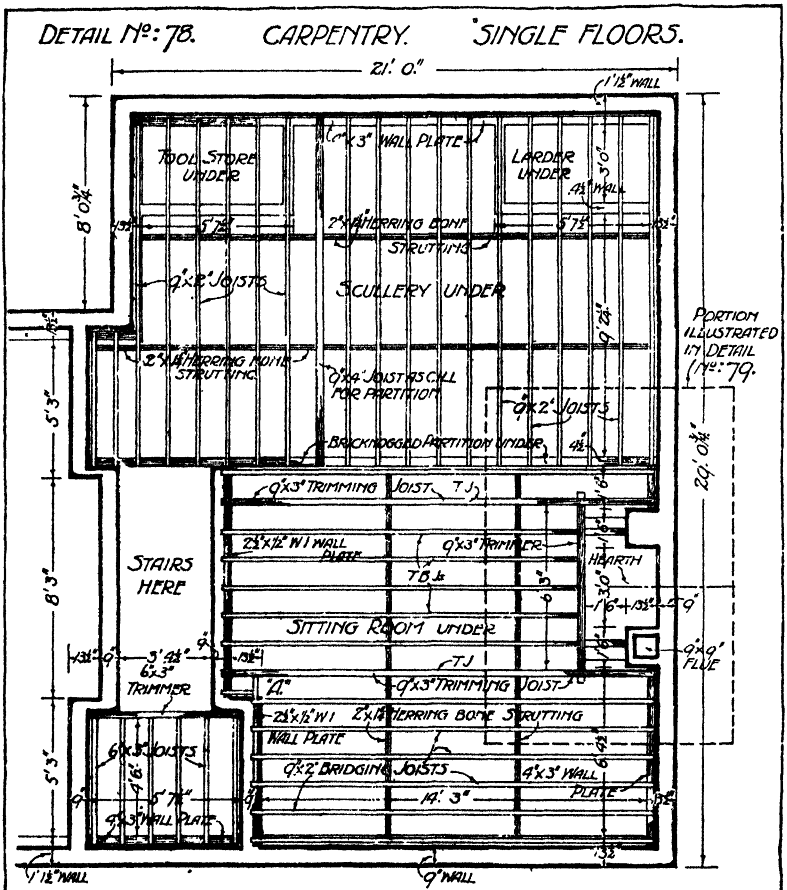
UPPER FLOORS

205. Floors up to 16 ft. span *above* the ground floor are usually of the "single span" type; in which the joists rest on the surrounding walls of each ground floor room, and have no intermediate bearing or support. In these cases, to avoid joists entering the walls at chimney breasts and to provide a fire resisting hearth, they have to be supported on timbering fitted round the fireplace opening, which we have already referred to as trimming.

206. Trimming—general description. Trimming is the framing of constructive material round an opening or obstacle in a floor, roof, or ceiling.

It consists of placing main carrying timbers at the sides of the required opening or enclosure, which in their turn carry a strong

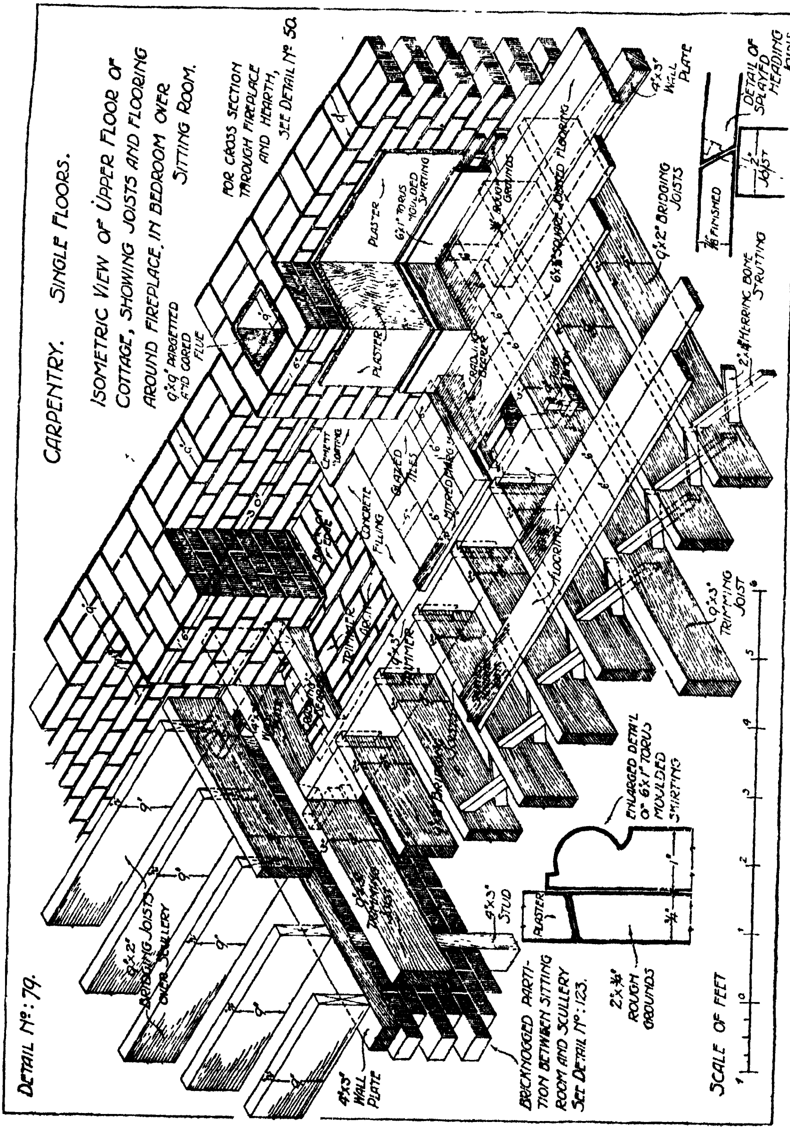
cross timber whose function is to support any intermediate pieces which, if continued, would cross the opening.



PLAN OF PART OF UPPER FLOOR OF COTTAGE OVER SITTING ROOM AND SCULLERY, SHOWING ARRANGEMENT OF THE BRIDGING JOISTS AND TRIMMING AROUND FIREPLACE.

SCALE OF FEET. 1 0 5 10 15

207. Trimming timbers. "Trimming timbers" are the main carrying pieces referred to above. They form the "sides" of the opening parallel to the direction of the common timbers. In a floor or ceiling they are known as "trimming joists" and in a roof as "trimming rafters."


CARPENTRY. SINGLE FLOORS.
ISOMETRIC VIEW OF UPPER FLOOR OF COTTAGE, SHOWING JOISTS AND FLOORING AROUND FIREPLACE, IN BEDROOM OVER SITTING ROOM.
FOR CROSS SECTION THROUGH FIREPLACE AND HEARTH, SEE DETAIL No 50.
DETAIL No: 79.
PLASTER
GLAZED TILES
CONCRETE FILLING
FLOORING
DETAIL OF SPLAYED HEADING JOINT
WALL PLATE
BRIDGING JOISTS
HERRING BONE STRUTTING
TRIMMING JOIST
ENLARGED DETAIL OF 6"x1" TORUS MOULDED SKIRTING
BRICKNOGGED PARTITION BETWEEN SITTING ROOM AND SCULLERY SEE DETAIL No 123.
ROUGH GROUNDS
STUD
SCALE OF FEET

208. Trimmer. A "trimmer" is a cross timber—generally at 90° to the common direction—carrying the ends of the "stopped timbers." The name applies in all cases.

209. Trimmed timbers. "Trimmed timbers" are the pieces whose stopped ends are supported by a trimmer—in a floor they are "trimmed bridging joists" and in a roof "trimmed rafters."

210. First floor. Applying the features to a first floor, say floor above sitting room of the cottage, detail No. 78, we have the following special timbers introduced:

(*a*) Trimming joists at the ends of the hearth opening marked T.J.

(*b*) Trimmer between these and parallel to chimney breast.

(*c*) Trimmed bridging joists, parallel to trimming joists and supported by the trimmer, marked T.B.Js.

Observe that the common floor joists which bridge the span from wall to wall are termed "bridging" joists.

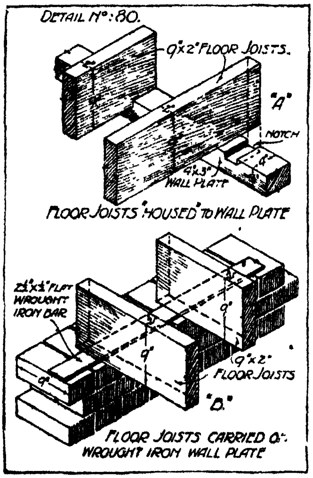
211. Bearings. Before dealing with the "jointing" of the trimming timbers, notice that they, along with *all* the joists, are supported upon "wall plates" as before. At the outer wall the plate rests on an offset, but at the division wall between room and staircase the joists enter the wall. This latter method is quite common for all walls above the ground floor; but the ends should *not* be walled close, for this prevents any ventilation and induces decay under unfavourable conditions.

The isometric detail No. 79 shows a portion of this floor and indicates the method of "trimming" necessary around the hearth and chimney breast.

212. Notched plates. Instead of resting the joists directly upon the timber plate without any cutting, as indicated in the ground floor details, single span upper floor joists are often jointed to the plates by "notching" or "cogging."

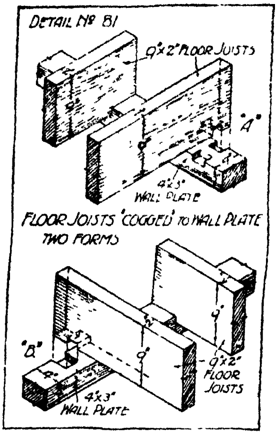
This does not increase their strength nor does it presume to do so.

Plates may be notched $\frac{1}{2}''$ to $\frac{3}{4}''$ deep to provide "housing" for the joists as per detail No. 80 at A, which prevents "side movement" of the joists and ensures "proper spacing." Good work also assists in securing a level bearing, and variations in the depth of the sawn joists are easily rectified by adjusting the depth of the notch to suit them. A more certain way of obtaining a true floor surface is to level the plates with prepared notches $\frac{3}{8}''$ or $\frac{1}{2}''$ deep, pick out the shallowest joists and sink



the ends of all the rest to this dimension, by notching them on the under edge. When placed in position the top edges will then be in one plane and any variation of surface which would occur in the ceiling could be rectified with the plaster.

213. Cogging has for its object the provision of a tie between joist and plate, and to prevent horizontal movement in any direction. Two forms are shown, each consisting of a notch near the end of the joist and a "tooth" or "cog" on the plate—detail No. 81.



Example A cannot be recommended. A little sagging of the joist causes the short piece at the back to be "shorn" off, leaving the joist bearing more or less upon the cog. Example B is a little stronger because the cog is at the front of the plate and more length is provided behind the notch of the joist.

214. W. I. bearing plate. Wall plates or "bearing bars" of wrought iron have often been substituted for wood plates in modern work as in detail No. 80 B. A plate $2\frac{1}{2}'' \times \frac{1}{2}''$ is laid 1″ within the wall and the joists bedded upon it. Its advantage is, that more timber has been eliminated and the chance of decay at the bearing of the joist is therefore less.

215. Level bearings. It is fairly certain that notching of the plate (and of the joist when it exceeds the minimum) is the best method of the series, for, if carefully made, the bearing remains level; it is not reduced in size, allows of spiking through the side for security against movement, troublesome variations of depth are provided for and it is the most economical of the jointed forms. With good and sufficient external walling, square, uncut bearings are perfectly satisfactory especially with buildings of only two or three storeys in height. We recognise here that floor joists have a great effect in tying walls together; for this reason some architects make a practice of crossing their directions from floor to floor in a succession of storeys.

216. Joints in trimming. We must now consider the method of jointing the timbers in the hearth trimming of detail No. 79.

The following provisions are necessary in preparing them:

(*a*) To provide and maintain sufficient strength for transmitting the loads to be carried.

(*b*) Security against withdrawal.

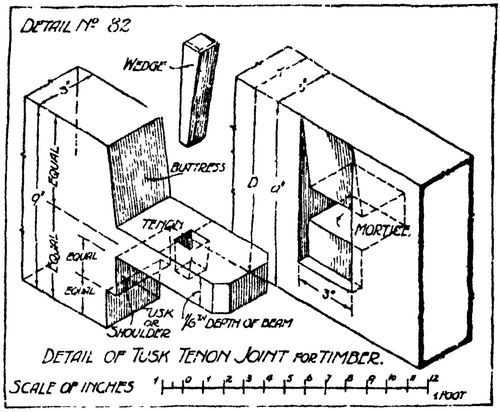
(*c*) Ease of assembly.

(*d*) Economical formation.

217. Size of trimming timbers. To enable a sound construction of the joint to be effected and sufficient strength to remain after jointing, all trimmers and trimming joists are made at least 1″ thicker than the bridging joists in the same floor. In this case we are employing 9″ × 2″ bridging joists, hence the jointed members are 9″ × 3″.

Because the trimmer (detail No. 79) tends to sag considerably when loaded from the numerous joists it carries, the ends of the trimmer tend to tilt the trimming joists out of the vertical, and when these resist a great strain on the joint occurs. It must therefore be "rigidly fixed," and sufficient "bearing" must also be provided where one timber enters the other.

218. Tusk tenon joint. The best practical method of doing this is to use a "tusk tenon" joint, which has a tenon whose thickness is $\frac{1}{6}$ the depth of the joist, placed in the centre, passed right through



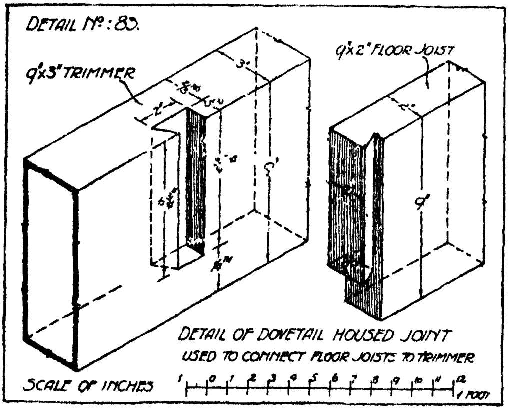
the trimming joist and projecting 4″ at least beyond it. To relieve the tenon of much load, a second bearing piece called a "tusk" projects from the lower shoulder of the tenon, $\frac{5}{8}$″ to $\frac{3}{4}$″ long for a 3″ joist, and half the depth of this shoulder. The "tenon" is then available for drawing the joint close, which is done by a single wedge as shown in isometric view of floor—detail No. 79 and enlarged detail No. 82. The wedge bears against the outer edge of the slot in the tenon receiving it, and against the face of the trimmer joist; $\frac{1}{8}$″ clearance is allowed in the "back" of the slot to ensure "forward" movement. *Tenons placed out of the centre* of the depth do not draw up equally at the shoulders.

The bevelled shoulder at the top surface of the tenon acts as a buttress, and prevents the splitting of the member along the under side of the tenon, which would occur if the load were borne by the tenon instead of *chiefly* by the tusk.

Proportions of tusk tenon joints are important and we therefore assemble them for reference when applied to pieces of equal depth. Let D = depth of joists, T = thickness of trimming joist, t = thickness of tenon, then $t = \frac{1}{6}D$, depth of tusk $= \dfrac{D - t}{4}$, projection of tusk and buttress $= \frac{1}{6}$ to $\frac{1}{4}T$. Minimum projection of tenon 4″, thickness of wedge $\frac{3}{4}''$ at least. The inclinations of the wedge and hole must fit each other exactly and the angle contained by the wedge should be about 5°.

219. Joint at trimmed joists. Where the intermediate joists connect to the trimmer, a tusk tenon might be used, without the projecting tenon and wedge, because these would be in the way of the brick trimmer arch and get too far into the opening. If used, the joint is spiked or pinned through the depth of the trimmer, or spiked "endwise" on the slope.

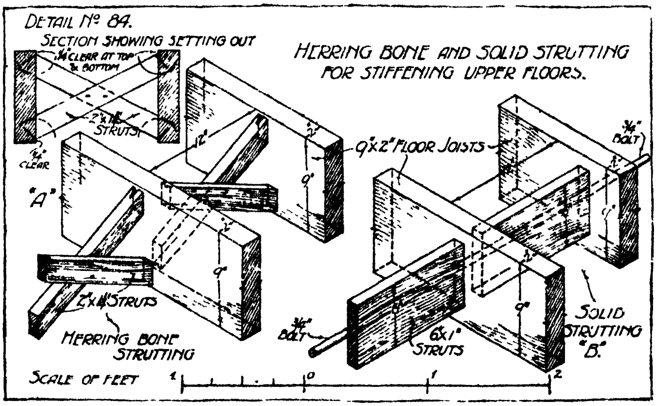
220. Dovetailed housing or notch. A very good alternative, used almost exclusively for trimming in many northern districts of this country, is the "dovetail housed" or "notched" joint illustrated



in detail No. 83. The trimmed joist is notched on the under side $\frac{3}{4}''$ to 1″ long and $\frac{1}{4}$ to $\frac{1}{3}$ the depth of the joist, then sunk along one side of the projection to form a dovetail having a bevel of about 10°. A corresponding housing on the top edge of the trimmer allows the joist to be driven downwards, ensuring good bearing and security against withdrawal. It is usually spiked with two 6″ wire nails in addition, which are dovetailed inwards from the end.

221. Housing. In cheaper work a similar housing is employed but without the dovetail, spiking being depended upon for security.

222. Herring-bone strutting, etc. Deep narrow joists (which are a great advantage in making a floor "rigid," thus preventing vibration) are subject to "side-tilting" in long spans; in addition, the flooring boards, themselves provided to cross "short" spans, do not distribute load effectively unless the joists are connected sidewise. To prevent "side buckling" and to connect the whole fabric rigidly, a system of bracing or strutting is introduced at 5 to 6 ft. intervals across the length of the floor. This strutting, of whatever form, must pass in continuous lines across the whole floor, unless placed opposite the ends of a trimmer, which is one usual "starting line" for the spacing of the strutting. The form in commonest use is known generally as "herring-bone strutting" and in the North of England as "X bracing." Its detail is clearly seen in illustrations at details Nos. 79 and 84 A, and consists of pairs of diagonals 2″ × 1¼″ or 1½″,



accurately cut on the splay, fitted between and nailed to the joists and placed close together. The ends should be ¼″ clear of the top and bottom edges of the joists, to prevent the struts bearing against the floor boards and ceiling after shrinkage of the joists, which is inevitable. Struts are nailed with single nails 2½″ to 3″ long, and the splay ends of the piece are often sawn or slotted for a short length down the centre to avoid splitting, as shown in detail No. 84. Until the end struts are fixed, the wall joist should be lightly wedged to make it rigid. In districts where strong walls are customary this wedging is made tight and permanent.

To place a strut in position on a drawing, mark the point of the strut at top and bottom on opposite faces of the two joists, strike arcs with the depth of the piece as radius (see detail No. 84 A), placing the lines to pass through the "point" at one end and tangential tc the arc at the other.

223. Solid strutting. Solid strutting consists of placing short pieces of timber tightly between the joists in a straight line, and securing them firmly by placing a $\frac{3}{4}''$ bolt through the joists at the centre of their depth, close to the line of struts and gripping the series tightly from the ends—detail No. 84 B. This method is faulty because the top and bottom edges are least secured, shrinkage and warping of joists make the struts slack or ill fitting and the distributing power is small. Further, the strutting is useless without the bolt, which must be inserted when the floor is laid.

224. Hearths. We have previously shown how the hearth is carried by a brick trimmer arch, and levelled up for tiling. It is now necessary to explain the mode of finishing the boarding round the hearth. Although the trimming of the floor has left an opening the full width of the breasts in order to avoid timber entering therein, we have pointed out before that the upper hearth needs to be only 6″ wider than the fireplace opening at each end.

It is therefore necessary to support the flooring boards for some distance across the breast, without allowing any timber to enter the brickwork. Detail No. 79 shows how this is done. Before filling up with concrete a 3″ cradling piece or bearer—cut to fit the back of the arch and to stand level with the joists—is laid upon the trimmer arch at the required position, the concrete deposited within and also for a short length outside it if desired. The boards are thus supported at the end overhanging the hearth trimming.

225. Hearth margin. To provide a neat and accurate finish to the hearth tiling, a $2'' \times 1''$ hard wood margin is placed round the hearth, nailed to the trimmer and trimmer joist, and mitred at the angles. The floor boards thus lap 1″ upon the timbers and may be nailed securely to them.

Occasionally the margin is "rebated" over the floor boards but we have illustrated a "square edged" margin in detail No. 79.

226. Short trimmings. Short trimmings are often necessary, as for example at the left-hand side of detail No. 78 at A, near the stairs. Dovetailed notching would be used here.

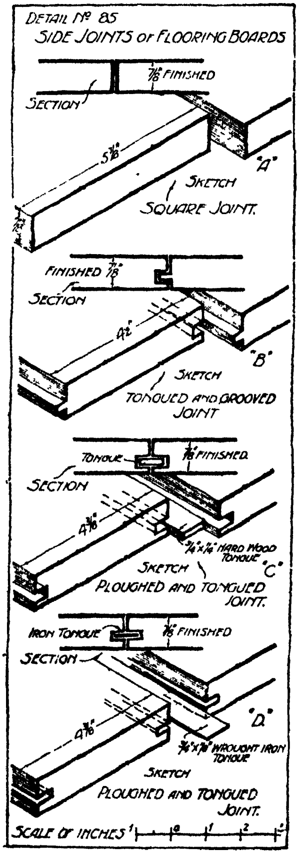
227. Untrimmed upper floors to cottage. Detail No. 78 shows the first floor above the scullery, where no trimming is necessary owing to the absence of flues and fireplaces.

The joists should in any case be arranged to run across the short span of the space to be bridged unless this is an inconvenient direction.

228. Ceilings. Where an unbroken ceiling is required the joists of a floor must be kept the same depth throughout, even though the span be short enough in parts to allow reduction for strength.

Over the entrance lobby the joists are less, because the ceiling does not interfere with other parts.

229. Flooring joints. Square jointed flooring is again shown in the isometric detail No. 85 A, and the method of laying has already been described. It must be understood, however, that in most parts of the country square edged boards for "single-boarded" floors have been abandoned for a considerable time. Some form of jointing the edges to prevent dirt passing between, to obviate draughts and to secure the boards in some measure against warping at the edges is adopted.



230. Edge joints. The most general method of preparing board edges is to "tongue and groove" them. The boards are prepared wholesale, with a tongue on one edge and corresponding groove on the other, so that when boards are placed edge to edge they fit neatly and fairly tight, with "flush" upper surfaces. Such boards vary from $\frac{7}{8}''$ to $1\frac{3}{8}''$ finished thickness and $4\frac{3}{8}''$ to $5\frac{7}{8}''$ finished width "overall."—Detail No. 85 B.

A good board for house floors is $5'' \times 1''$ (really $4\frac{7}{8}'' \times \frac{7}{8}''$) with a tongue $\frac{3}{8}''$ wide, making the board for covering purposes roughly equivalent to a $4\frac{1}{2}''$ plain square board; thus, about 10 % of the "covering power" of the board has been wasted in preparation; still, the advantages are largely on the side of the jointed boards.

The proportions of the tongue and groove are shown in this detail, the top edge of the tongue being near the centre of the depth to allow of longer wear.

Where small quantities of jointed boards are being prepared by a builder for a special purpose, other methods of forming the edge joints may have to be adopted. For example, the edges of adjacent boards may be grooved, and a separate tongue inserted either of wood or iron, as illustrated in detail No. 85 at C and D. This does not save any expense of material because the separate tongues have to be provided; it is more convenient, however. The result is termed a "ploughed and tongued" joint.

For hard wear and for hard-wood boards, metal tongues are good, strips of $\frac{3}{4}'' \times \frac{1}{8}''$ wrought iron being inserted below the centre of the joint, making an excellent but expensive floor.

231. Heading joints. Where boards have to be jointed endwise on a narrow joist, the board ends may be cut on the bevel as in detail No. 79, and secured by two skew nails passing through both pieces. This form is known as a "splayed" heading joint.

On a broad joist (3″ or more) square ends jointed at the centre with two sets of nails are better, because the bevelled end is liable to splinter with wear; it is often badly laid and left a little raised at the joint, which accentuates the fault. In soft wood the "square" heading is preferable.

232. Selection of flooring. In selecting and arranging boarded flooring care should be taken to choose boards with suitable grain. Boards having their annual rings almost vertical wear best and shrink least, and those with the heart side of the board on the top surface are least satisfactory, being liable to lift ring from ring.

Tongues should "fill" but must not be very tight, otherwise free expansion and contraction is interfered with and tongues may split longitudinally.

"Narrow boards" cut from *matured wood* make the best floor, because the total shrinkage is distributed over more joints, making the openings proportionately less.

CHAPTER NINE

PERMANENT CARPENTRY

Roofing

233. A roof is a "covering." Its function is to protect the enclosure over which it is erected from wind and weather, and in this country, owing to atmospheric conditions, for "domestic buildings" it means the provision of a structure which shall be proof against rain and snow, resist penetration of cold and the escape of artificial heat, and maintain its form under the weight of its covering and wind pressure.

Roof construction consists of "supports" and "coverings." We shall, at present, confine our attention in detail to the supports, first obtaining a due conception of the shape and size of the covering materials and their effect on the form and disposition of the framing.

234. Coverings. Coverings may consist of sheets of special felt, rubber preparations, lead, asphalte, corrugated iron, slates and tiles.

235. Slope of roof. The kind and size of material decide the slope of the surface (within limits) on which the covering is to be laid, in order to prevent rain penetrating at the joints.

"Asphalte," being laid to form a continuous covering, may be nearly flat.

"Lead" needs little fall because of the methods adopted for joining the sheets, due to peculiarities of the metal (see later chapters).

"Felt and ruberoid" sheets, being in large pieces, easily lapped and secured, may have a medium slope—less than that of slates —see table, par. 237. "Corrugated iron" would be a little steeper.

"Slates," if large, may have a flatter pitch than small ones, and "Plain Tiles," being small, need the steepest slope of any type of covering.

The reason for the statements concerning the required slope for slates and tiles will be evident when we consider that the only convenient mode of securing them is to fix the slabs with nails in positions at least higher up the slope than half their length, which leaves them capable of being lifted in a wind (see also chapter on Slating). Increase of slope means less liability to lift and a "tighter" covering.

236. Method of measuring and referring to roof slopes. Commonly, the slope of a roof is called its "pitch." It may be measured and stated in degrees—the usual scientific method—but is more generally expressed by architects and builders in terms of the relation of "rise" to "span."

"Span" here means the gross width covered by the roof, and "rise" means the "vertical height" of the highest point above the lowest in a symmetrical roof with two slopes.

When a roof is stated to be $\frac{1}{4}$ pitch, it means that the *rise is $\frac{1}{4}$ of the span*. If $\frac{1}{3}$ pitch, the rise is $\frac{1}{3}$ of the span.

237. Minimum slopes for chosen coverings. Although exigencies of practice may cause a variation in the choice or possibility of pitch, and govern also the selection of the covering material, the following table should be accepted as giving the *minimum* slope which may be wisely employed for the given material under average conditions (see detail No. 86 for illustration).

Material	Pitch		Angle of inclination (approximate)
Lead	$\frac{1}{80}$		Less than 2°
Corrugated iron	$\frac{1}{10}$		11°
Felt, Ruberoid	$\frac{1}{8}$	Measured	14°
Pantiles	$\frac{1}{4}$	on	24° to 26°
Slates (large)	$\frac{1}{4}$	"span"	26°
,, (small)	$\frac{1}{3}$	roofs	33°
Plain tiles	$\frac{1}{2}$		45°

238. Temporary roofs. Because "felt," "corrugated iron" and "ruberoid" do not come within the scope of the present work as permanent external coverings, we shall concentrate our attention on the provision of the supporting timber work for the average types of slated, tiled and lead covered roofs.

239. Terms employed in roofing. Detail No. 87 illustrates the terms employed in connection with roofs of the kinds we have used in the cottage and workshop under consideration. Refer the following descriptions to the detail, and study carefully.

Eaves. The lower edge of the inclined roof surface; generally horizontal. It may overhang the walls of the building.

Ridge. The highest line in the roof; the termination of the inclined surface at the top of the slope.

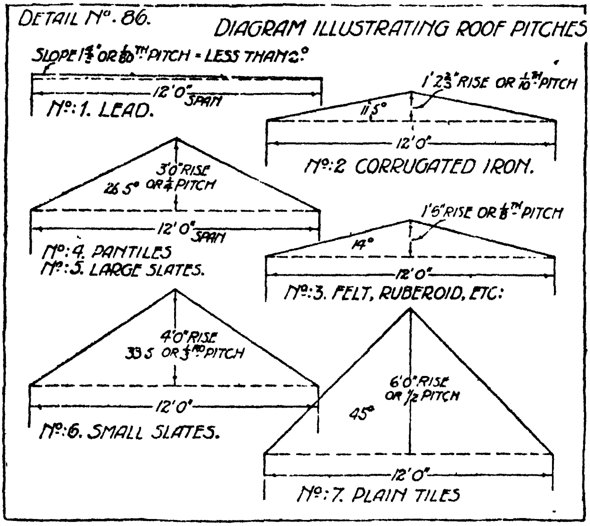
Gable. The triangular portion of walling formed by continuing a wall up within the roof, the ridge being prolonged to its face.

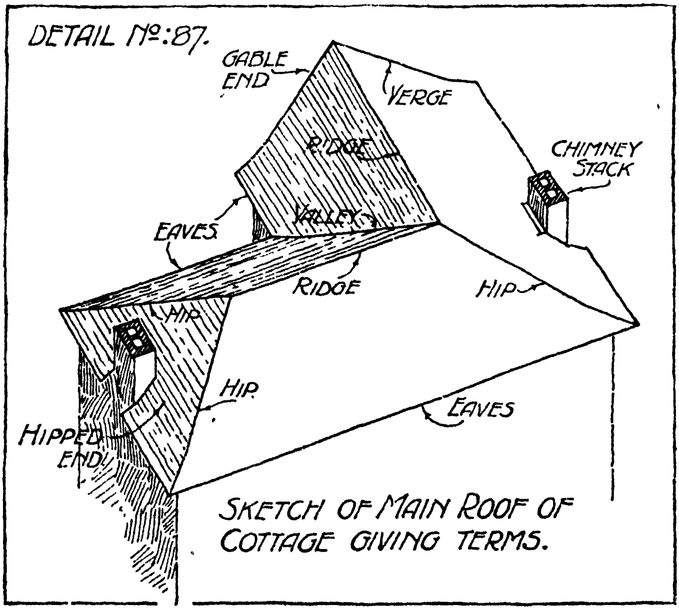
Verge. The overhanging edge of the covering at a gable.

Hip. The line of intersection of two roof surfaces which contain an external angle *greater than* 180°. Has a "sharp" angle on the outside.

Valley. The line of intersection of two roof surfaces containing an external angle *less than* 180°. Has a "recessed" angle on the outside.

Hipped end. The triangular surface formed by continuing the roof slope round the "end" of a building, ranging from eaves to ridge and bounded at the sides by two hips.


DETAIL No. 86.
DIAGRAM ILLUSTRATING ROOF PITCHES
SLOPE 1¾" OR 1/80TH PITCH - LESS THAN 2°
12' 0" SPAN
No: 1. LEAD.
1' 2⅖" RISE OR 1/10TH PITCH
11.5°
12' 0"
No: 2 CORRUGATED IRON.
3' 0" RISE
26.5° OR ¼ PITCH
12' 0" SPAN
No: 4. PANTILES
No: 5. LARGE SLATES.
1' 6" RISE OR 1/8TH PITCH
14°
12' 0"
No: 3. FELT, RUBEROID, ETC:
4' 0" RISE
33.5 OR 1/3RD PITCH
12' 0"
No: 6. SMALL SLATES.
6' 0" RISE
OR ½ PITCH
45°
12' 0"
No: 7. PLAIN TILES


DETAIL No: 87.
GABLE END
VERGE
RIDGE
CHIMNEY STACK
EAVES
VALLEY
RIDGE
HIP
HIP
HIP
HIPPED END
EAVES
SKETCH OF MAIN ROOF OF COTTAGE GIVING TERMS.

240. Roof members used in construction and illustrated in detail No. 98.

Rafter. An inclined member, approximately parallel to the slope of the covering, of comparatively light material. Called "spars" in the North of England. The top end of a rafter is called its "head" and the lower end its "foot."

Jack rafter. A short rafter, spanning from the eaves to a "hip" or "valley" and fixed to the *sides* of the latter.

Purlin. A horizontal member supporting the common rafters when these are too long for construction in average size timbers. Purlins derive their support from "cross walls" or from *timber frames* called *trusses.*

Wall plate. The plate—generally horizontal—resting on the external wall to "receive" and provide "fixing" for the feet of the rafters.

Roof Accessories

241. Eaves gutter. A trough of wood, cast iron or zinc, or of "lead lined" wood or stone, which is fixed at the eaves of a roof to collect and transport rain water to the down pipes.

242. Down pipe. A vertical pipe of zinc, lead or cast iron which conveys rain water from the eaves gutters to the drains, or other place of disposal.

243. Roof boarding. Boarding laid on the rafters (at right angles thereto) on which the covering is placed. Often called "sarking boards."

244. Tile and slate battens. Substituted for complete roof boarding or secondary thereto; $1'' \times \frac{3}{4}''$ to $2'' \times 1''$ laths laid lengthwise of the roof, suitably spaced for securing tiles or slates (see chapter on Slating).

Other terms occurring later are tilting fillet, soffit, fascia and sprocket; these will be best understood when studying their application.

Types of Single Roofs

245. A roof is termed a "single roof" when it is constructed with one set of rafters supported at their ends only.

Detail No. 88 shows various forms of these roofs. We shall briefly refer to them here and explain more fully their construction and use when applying them in suitable combinations in our buildings.

Lean-to. A roof of one slope appearing to lean against a higher wall.

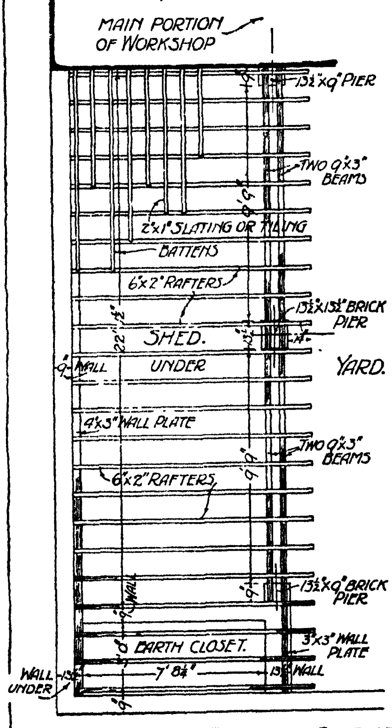
Couple roof. A roof of two slopes rising from a level eaves on each side and intersecting at a ridge.

although greater spans may reasonably be covered by employing larger timbers.

In most roofs, the primary support to the covering is provided either by laths or boarding, laid at 90° to the slope, as explained previously. To provide support for these, members inclined at the true slope of the roof are fixed, already referred to as "rafters." These form the roof proper—from the carpenter's point of view—and are the essential part providing an area of wooden framework over the whole enclosure as shown in detail No. 90, which is a plan of the complete shed roof and its supports.

In a well-designed roof the common rafters vary from 3″ × 2″ or 2½″ to 6″ × 2″, according to their unsupported length, the weight of the covering and the spaces between them. The present example has an unsupported length (on the slope) of 8′ 6″ and 6″ × 2″ rafters have been deemed necessary at 12″ apart.

DETAIL No. 90.



PLAN OF LEAN-TO ROOF OVER SHED OF WORKSHOP TO BE COVERED WITH SLATES.

SCALE OF FEET 1 0 1 2 3 4 5 6 7

247. Eaves girder. If this roof had been provided over an enclosure walled in on every side—*e.g.* a scullery, etc., projecting from a main building—the rafters would have been supported at both 'head" and "foot" on wall plates fixed to, or supported upon, the walls direct.

This shed, being open at the front, requires a girder across the opening strong enough to carry the feet of the rafters; it is clearly shown on the right-hand side of detail No. 89 and is built up of two 9″ × 3″ deals, packed apart and bolted, with a ⅞″ soffit board framed between them. The application is similar to the built up lintol of detail No. 71, with packing pieces of 4½″ × 3″ material 6″ long, grain vertical and spaced approximately at 3 ft. centres along the beam; ½″ bolts with 1½″ washers secure the parts.

The soffit board—tongued to the flitches—is not a necessity, but shows how appearance may be improved where desired.

248. Bearings. Observe that the rafters are supported on level bearings provided by the front girder at the foot, and by a wall plate laid upon an offset at the head. The level bearings are obtained by bevel notching the rafter to the plate and beam, see detail No. 89, such notch being known as a "birdsmouth"; its depth should not exceed $\frac{1}{3}$ the depth of the rafter.

At the foot of the roof, a short strut is inserted under each rafter, "housed and square notched" at the head and "tenoned" at the foot into the back flitch. This arrangement effectively shortens the span of the rafters which would otherwise have been 9′ 2″ at the selected pitch.

249. Overhanging eaves. The foot of the roof overhangs the front girder 1′ 4″ which serves as a protection to the timber beam and encloses more shed space. The weight of this part also helps to balance the weight of the roof between the supports, reducing sagging. It may be noted here that by adopting a light covering the rafters could be reduced to 4″ or $4\frac{1}{2}$″ × 2″.

250. Eaves gutter. A solid 6″ × 4″ wooden eaves gutter is provided to receive rain water, and supported on the notched feet of the projecting rafters.

251. Wrought and unwrought timbers. Roof timbers may be "wrought" or "rough." In this case the girder and overhanging woodwork must be wrought (worked smooth with the plane), while the portions underneath the covering and behind the girder may be left rough sawn if desired.

252. Span roofs. Roofs of two slopes terminating at a sharp angle are known as "span roofs." This is the commonest form of roof outline, has a much greater architectural value than the lean-to roof and is capable of very varied treatment.

Its simplest detailed form consists of pairs of rafters with their feet resting on wall plates, meeting at the required inclinations upon a deep board running lengthwise of the roof at the highest part. This board is called the "ridge" or "ridge-piece." Its minimum size should be 6″ × $1\frac{1}{2}$″ for 3″ rafters and 7″ × $1\frac{1}{2}$″ for 4″ rafters.

Let the span of such a roof be small enough to require no further members to ensure its stability than a wall plate, ridge and rafters; it is then termed a "couple roof." The maximum economical span for a couple roof with 4″ × 2″ common rafters is about 12 ft. Note that this roof is still of the "single" type, having no intermediate supports to one length of rafter.

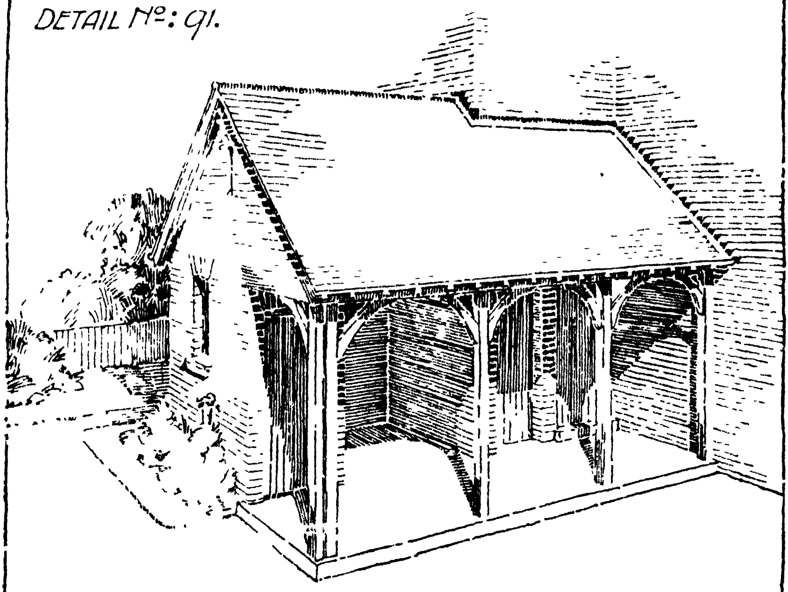
253. Back addition to cottage. Examine perspective detail No. 91, showing the roof over the back addition to the cottage; also

the isometric drawing of the same roof, detail No. 92. Note that a large portion of this roof is of the "span outline" and a smaller part continues the nearer slope—as a lean-to—forward to the main wall, forming a continuous covered way from the back door to the E.C., etc.

The clear width outside the supports is 11′ 6″ at the gable and of the lean-to portion 4′ 9″.—See plan, detail No. 93.

254. Lean-to. Consider the "lean-to" portion first. The rafters are carried on a 9″ × 4″ wooden beam at the foot, and at the head on a 4″ × 3″ wall plate supported by wrought iron corbel pins built into the wall as

DETAIL Nº: 91.



SKETCH OF ROOF AND COVERED WAY TO BACK ADDITION OF COTTAGE.

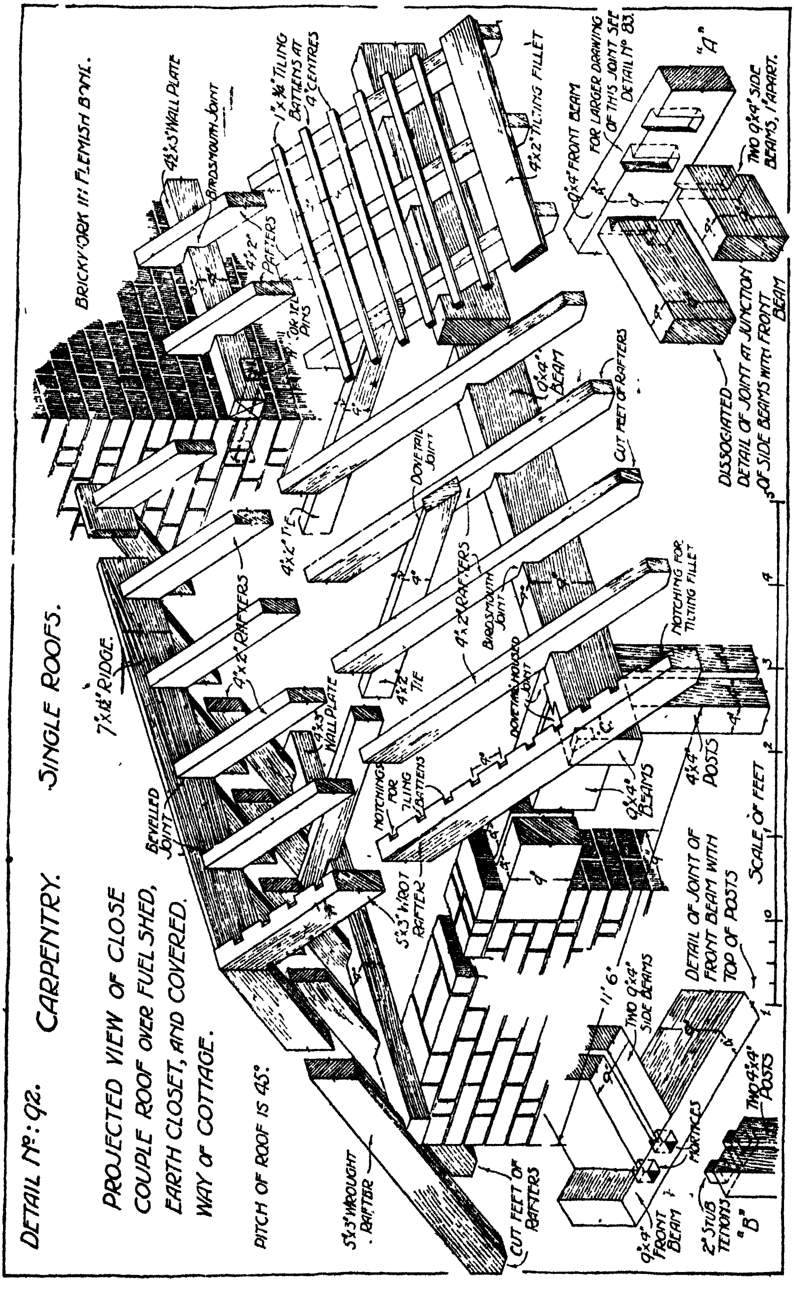
shown on the right-hand side of detail No. 92, and similar to that previously described for floors (detail No. 72). This wall plate is necessarily on the face of the main wall and may be supported in one of three ways:

(*a*) Building in, which is objectionable because liable to decay.

(*b*) Plugging to the face—not advisable, though it may be sound and rigid.

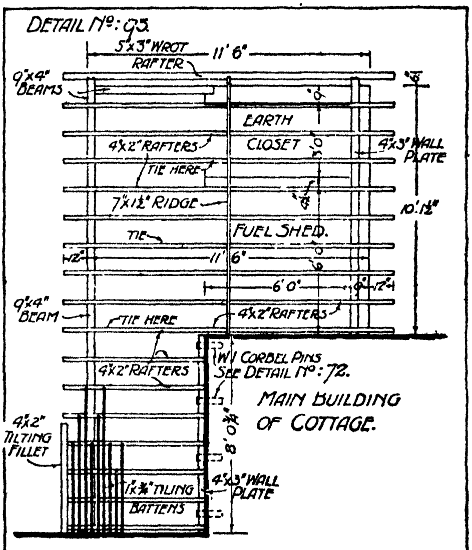
(*c*) Supporting on brick or wrought iron corbels as shown, which is the best method.

The rest of the detail is comparable with the detail of the shed roof to workshop, No. 89.


DETAIL No: 92.
CARPENTRY.
SINGLE ROOFS.
PROJECTED VIEW OF CLOSE COUPLE ROOF OVER FUEL SHED, EARTH CLOSET, AND COVERED WAY OF COTTAGE.
PITCH OF ROOF IS 45°
7"x1½" RIDGE.
BEVELLED JOINT
4"x2" RAFTERS
4½"x3" WALL PLATE
BRICKWORK IN FLEMISH BOND.
4½"x3" WALL PLATE
BIRDSMOUTH JOINT
4"x2" RAFTERS
OAK PINS
1"x¾" TILING BATTENS AT 4" CENTRES
4"x2" TILTING FILLET
4"x2" TILTING FILLET
4"x2" TIE
DOVETAIL JOINT
9"x4" BEAM
CUT FEET OF RAFTERS
4"x2" RAFTERS
BIRDSMOUTH JOINT
4"x2" TIE
DOVETAIL HOUSED JOINT
NOTCHING FOR TILTING FILLET
NOTCHINGS FOR TILING BATTENS
5"x3" WROT RAFTER
9"x4" BEAMS
4"x4" POSTS
9"x4" FRONT BEAM FOR LARGER DRAWING OF THIS JOINT SEE DETAIL No 83.
"A"
TWO 9"x4" SIDE BEAMS, 1' APART.
DISSOCIATED DETAIL OF JOINT AT JUNCTION OF SIDE BEAMS WITH FRONT BEAM
SCALE OF FEET
DETAIL OF JOINT OF FRONT BEAM WITH TOP OF POSTS
11' 6"
TWO 9"x4" SIDE BEAMS
MORTICES
TWO 4"x4" POSTS
9"x4" FRONT BEAM
2" STUB TENONS
"B"
5"x3" WROUGHT RAFTER
CUT FEET OF RAFTERS

255. "Couple" and "Close Couple" roofs. The couple roof detailed in No. 92 is not a "true couple," but a couple strengthened by the introduction of three horizontal ties over the open fuel shed (see plan, detail No. 93). At this part the back wall is not so rigid and the tendency of the weighted roof (when covered) is to cause the rafters to push the supporting walls or framing outwards.

A horizontal tie prevents this and in our case the tie is necessitated by the wooden framing supporting the open eaves



PLAN OF CLOSE COUPLE ROOF OVER BACK ADDITION OF COTTAGE, TO BE COVERED WITH PLAIN TILES.

having little weight, and therefore more easily disturbed than the wall.

Observe that when a couple roof is tied at the feet of the rafters, by horizontal cross-pieces to *each pair of rafters*, as in detail No. 88, it becomes a "close couple" roof.

In our case it is "partially" tied and is neither a "true couple" nor "close couple," but a combination of the two.

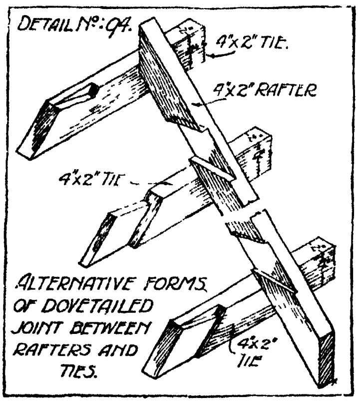
"Close couple" roofs are usually employed for spans of about 12 ft., but with stouter rafters are often used up to spans of 16 ft.

256. Collar roof. Should the ties be placed above the level of the wall plates so that a portion of each rafter is visible below the

tie, the roof is termed a "collar roof" and the tie a "collar," see detail No. 88. This type of roof is applicable to 16 ft. spans quite economically; the collar should be stronger than the rafters, being made "deeper," and should not be higher than "half the rise" above the wall plates.

Collar roofs utilise a part of the roof space, as the ceiling can be attached to the collars and the exposed parts of the rafters.

Special note should be taken of the variations in the form of joint which is most suitable for the connection of tie and rafter (see detail No. 94). It is "dovetailed" and "housed in" a portion of the thickness (the lower sketch shows the best form), and a ⅜" bolt should be employed to secure the joint. This type of joint resists either tension or compression successfully, and provides against the pull on the tie if the walls are pushed outwards on account of the rafters bending.

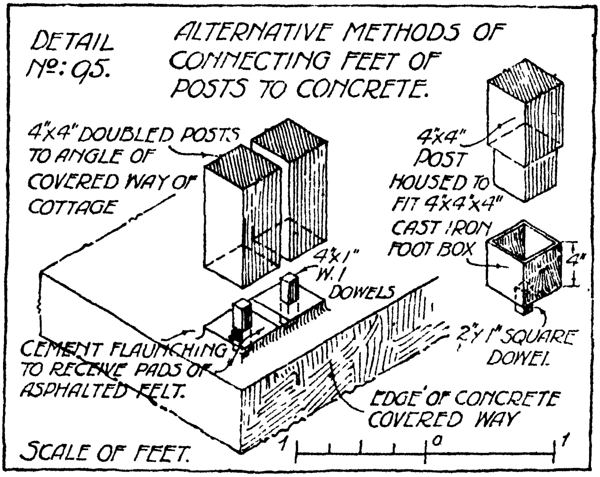


257. Support to eaves plate. The mode of supporting the eaves plate at the covered way, and of finishing the gable, requires notice. The eaves plate or beam is 9" × 4", enters the wall 4½" at the main building and derives further support from a post close to the wall; at the outer end two 4" × 4" posts are provided placed opposite to, and receiving the load from, a pair of 9" × 4" lintols which support the gable above. These lintols are placed flush with the two faces of the 9" gable wall, leaving a space between, and are jointed to the eaves plate by a pair of single housed dovetails as in detail No. 92 at A.

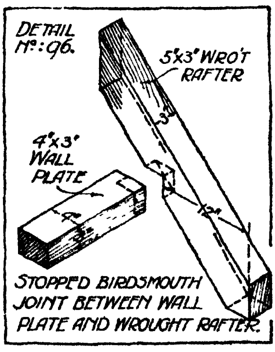
Two intermediate posts are provided under the eaves rail, and curved brackets, out of 2" × 9" material and 3½" broad at the narrowest part, transmit the load from the centre of each span to the posts, and stiffen the whole structure.

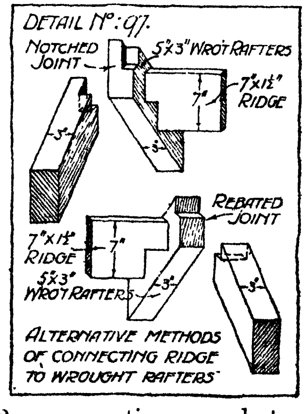
258. Feet of posts. The feet of the above posts are dowelled to the concrete with 4" × 1" × 1" metal dowels, the concrete being flaunched up from the main surface of the covered way. A square piece of asphalted felt coated with tar intervenes between woodwork (previously painted) and cement and provides against decay. As an alternative a dowelled cast iron foot-box may be employed. For illustration of both methods refer to detail No. 95. Also see note following paragraph 346.

259. Heads of posts. To joint the heads of the posts to the eaves plate, "stub tenons" are used, being short square tenons—in this case 2″ square—formed by "shouldering" the post all round. A corresponding "mortice" is sunk in the plate.—Detail No. 92 at B.



260. Gable finish. Referring now to the finish at the gable, it will be seen that larger rafters (5″ × 3″) are provided, the extra depth being necessary to receive the ends of the tiling laths, which are 1″ thick. The latter are notched in flush with the top surface of





the gable rafter, as in detail No. 92, or a continuous rebate of the same breadth and depth as the notches might serve a similar purpose.

The "stopped birdsmouth" joint between wall plate and wrought rafter in detail No. 96 and at C in detail No. 92 should be observed.

Detail No. 97 illustrates alternative methods of jointing the gable rafters at the head; the principle of the construction being to provide support to the ridge until the intermediate rafters are fixed.

General. The whole of the woodwork in the back addition to the cottage is intended to be wrought where visible on the exterior.

Double Roofs

261. "Double roofs" are employed where the average size of common rafter becomes too long to carry the load of the covering, etc.

Instead of adding to the "size" of the rafter—which becomes rapidly uneconomical in unsupported lengths above 7 ft. clear—larger timbers called purlins are introduced to provide intermediate support to the rafters, and at 90° thereto.

262. Purlins. Purlins may rest on "cross walls" or on other "roof timbers" and will vary from 3″ × 7″ for a 7 ft. span, to 4″ × 11″ for a 15 ft. span.

263. Cottage roof. The roof to the cottage is a span roof of the "double" type, and the terms applied to it have already been explained in connection with sketch detail No. 87.

After perusing this sketch carefully, study the plan and sections in details Nos. 98 and 99, which illustrate the complete arrangement of timber work. Notice the individual parts as follows:

First. Trace the outline of the external walls observing that the roof overhangs beyond the 9″ walls to a distance of 18″ to the extreme ends of the rafters. The projection is measured horizontally.

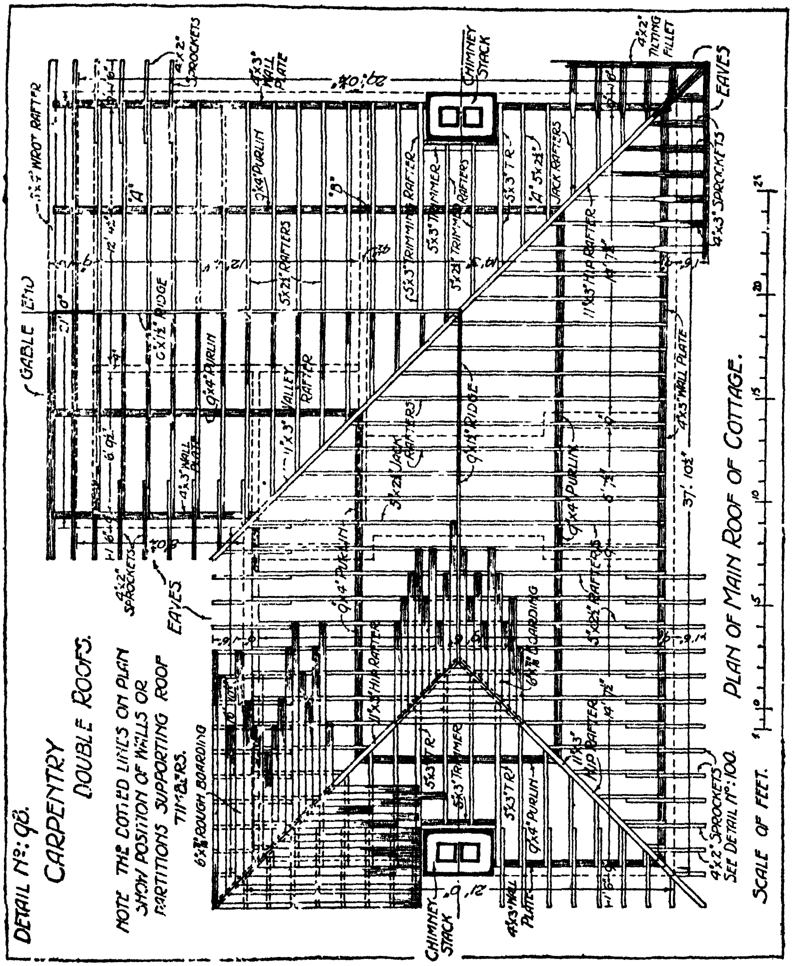
Second. Follow the outline of the main lines of intersection of the roof surfaces and compare them with sketch detail No. 87. These lines are ridges, hips and valley. In construction, the lines of these are necessarily replaced by timbers of a sufficient size to carry the adjoining timbers.

Third. Note that the common rafters, 5″ × 2½″, form the upper series of members all over the roof and that these fit (on the bevel) against the vertical faces of ridge, hips and valley and in all cases their plans are at 90° to the wall.

Fourth. Wall plates—4″ × 3″—are laid under the rafters, on the inside edge of all the external walls and the common rafters terminate on these.

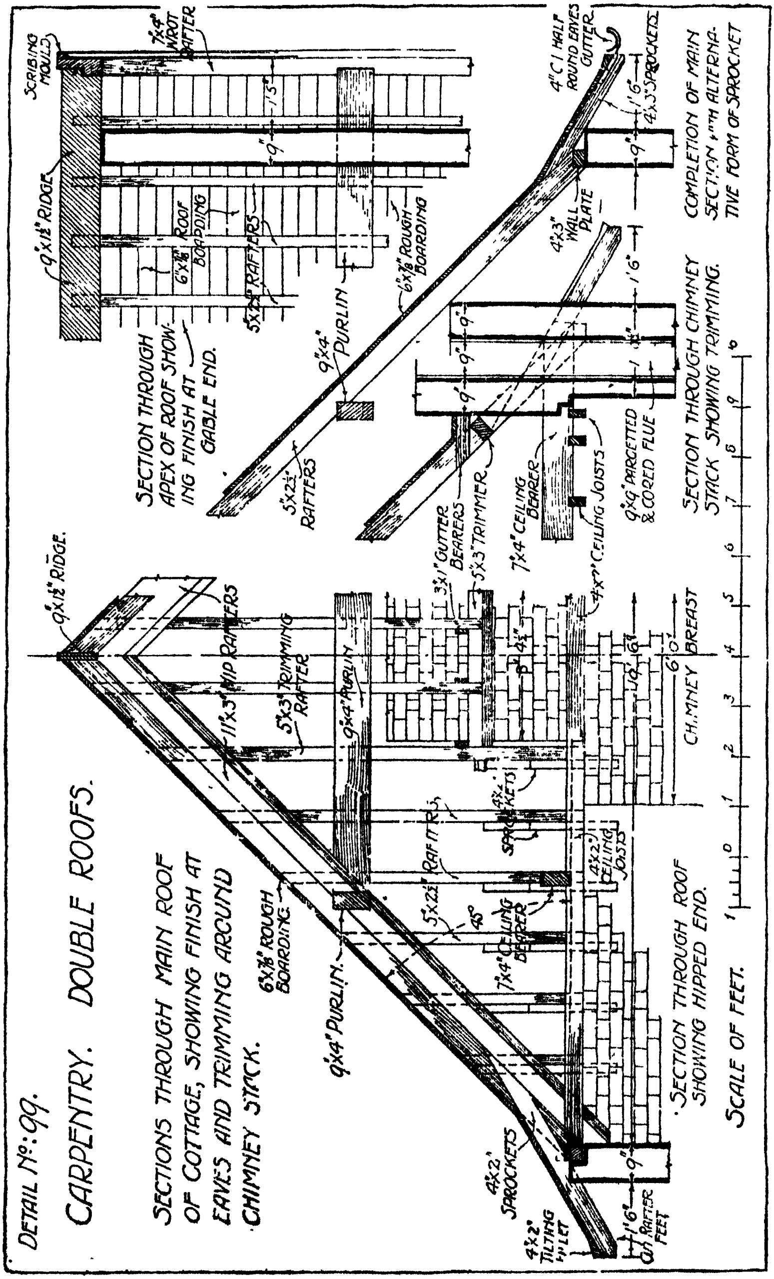
Fifth. Trace the outline of the purlins, and their points of support at cross walls and against the hips and valley.

At the gable end the purlins overhang 14″ to carry the wrought rafters which terminate the series of rafters at the verge. Purlins are in vertical planes, as is usual when supported by walls.



Sixth. Note the "trimming" which has been necessary at the chimneys, and the absence of roof projection at these places.

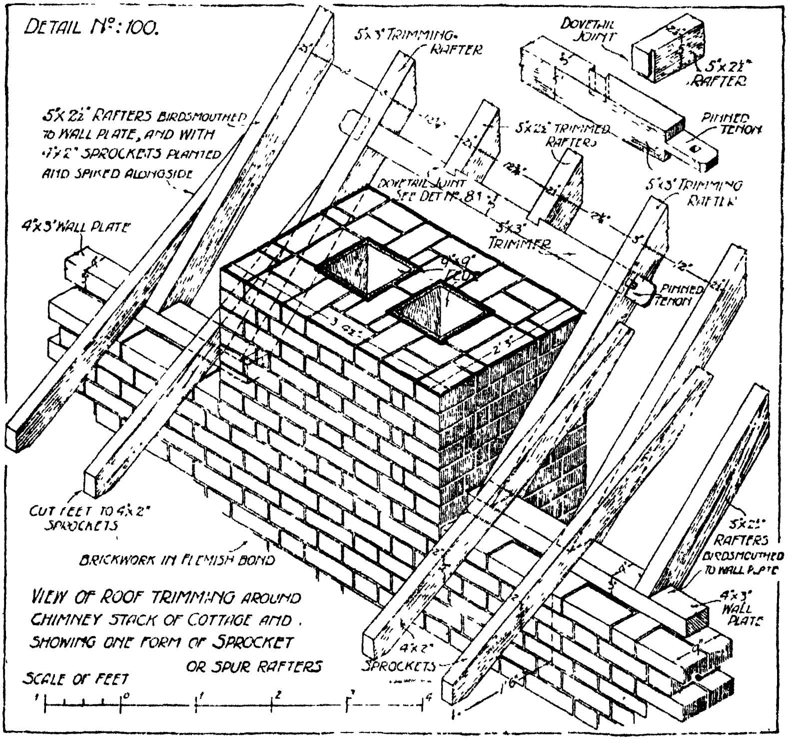
Seventh. Small portions of the roof surface are shown boarded closely in preparation for tiling; this covers the whole roof surface and ensures a warmer and more weathertight roof.



DETAIL No: 99.
CARPENTRY. DOUBLE ROOFS.
SECTIONS THROUGH MAIN ROOF OF COTTAGE, SHOWING FINISH AT EAVES AND TRIMMING AROUND CHIMNEY STACK.
SECTION THROUGH APEX OF ROOF SHOWING FINISH AT GABLE END.
SECTION THROUGH CHIMNEY STACK SHOWING TRIMMING.
COMPLETION OF MAIN SECTION WITH ALTERNATIVE FORM OF SPROCKET
SECTION THROUGH ROOF SHOWING HIPPED END.
SCALE OF FEET.
SCRIBING MOULD
9"x1½" RIDGE
7"x4" WROT RAFTER
6"x⅞" ROOF BOARDING
5"x2½" RAFTERS
9"x4" PURLIN
6"x⅞" ROUGH BOARDING
4"x3" WALL PLATE
4" C I HALF ROUND EAVES GUTTER
4"x3" SPROCKETS
3"x1" GUTTER BEARERS
5"x3" TRIMMER
7"x4" CEILING BEARER
4"x2" CEILING JOISTS
9"x9" PARGETTED & CORED FLUE
11"x3" HIP RAFTERS
5"x3" TRIMMING RAFTER
9"x4" PURLIN
4"x2" SPROCKETS
4"x2" TILTING FILLET
RAFTER FEET
CHIMNEY BREAST

264. Eaves finish to cottage. The projection of the roof at the eaves is formed by fixing short pieces of rafter—called "sprocket pieces"—to the feet of the longer rafters and at a flatter slope, by one of the two methods illustrated on opposite sides of the plan, one of which is detailed at No. 100. The purpose of this "break" in the inclination is to give a curve to the foot of the roof.

In one case, to the left of the plan, the sprockets rest on the edge of the wall plate, and are fixed by nailing to the



VIEW OF ROOF TRIMMING AROUND CHIMNEY STACK OF COTTAGE AND SHOWING ONE FORM OF SPROCKET OR SPUR RAFTERS

side of the rafter in addition to the plate. The sprockets are 4″ × 2″ (see detail No. 100), which incidentally shows the trimming round the chimney referred to later. On the right of the plan (detail No. 98) is shown a "flat sprocket-piece," 4″ × 3″, bevelled on to the rafter above the wall plate, so that it may be secured by nailing to the rafter. The former method is the stronger, more rigid and economical.

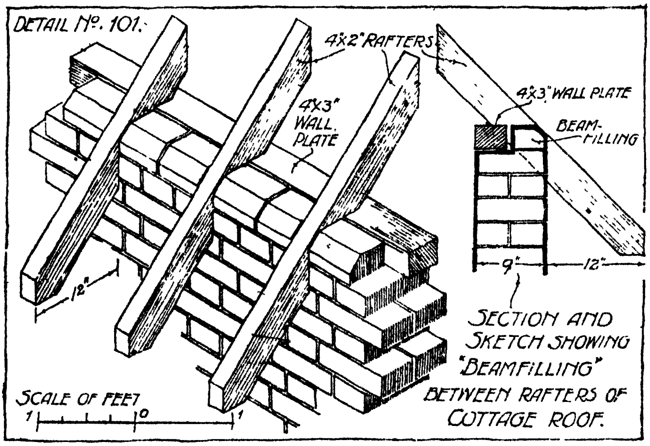
In both cases the sprockets derive some support from the wall on which they rest at the outer edge. The brickwork is often filled in and around them up to the level of the back of the sprockets and

rafters; the process is called "*beam-filling*" or "*wind-filling.*" Detail No. 101 shows the meaning of this term.

Eaves angles. The constructions of the eaves angles at the feet of hips and valleys are purposely omitted here, being too intricate for the present stage of study. Similar details will be dealt with in a later volume.

265. Jointing and support of roof members. Methods of arranging the detailed jointing and support of parts may now be considered.

Observe that the wall plates, purlins, and ridge are first set up if the roof be "plain." Plates must be laid level and efficiently bedded,



and any joints in their length are made, as in floor plates, by lapping and halving.

Purlins require a "bearing" of $4\frac{1}{2}''$ for 8 ft. spans, increasing to $9''$ for spans from 8 to 10 ft. Brickwork supporting purlins must be sound and well bonded, and a stone template ensures the proper distribution of the load.

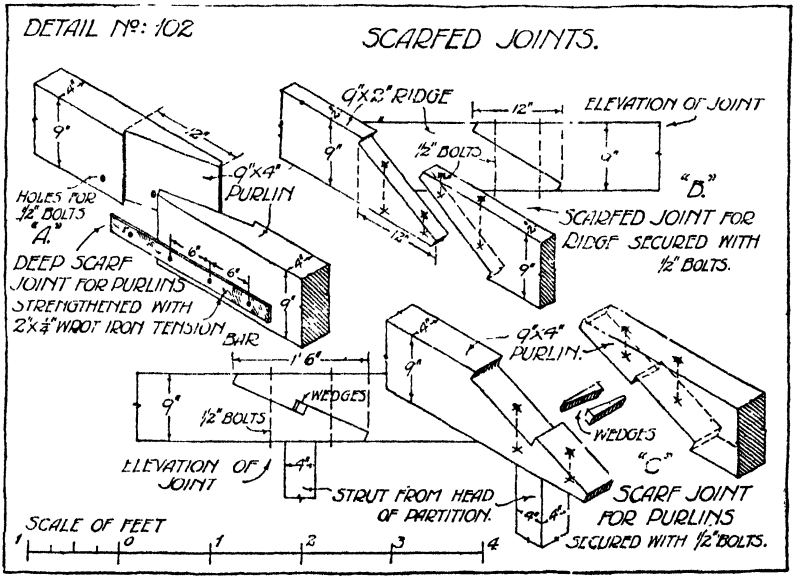
The ridge needs to be deep enough to receive the rafters when bevelled against it and thick enough to allow of secure nailing; $1\frac{1}{2}''$ may be accepted as the minimum. When fixed, the rafters support one another at their heads, if placed in "pairs."

266. Scarfed joint. Should a purlin or ridge require to be jointed in length a "scarf" is employed. A "scarfed joint" is any form of joint which ensures continuity of the length of the timber without increasing its sectional dimensions at the joint. Iron plates are commonly added to scarf joints on the tension side and half-lap "deep scarfed" joints are very efficient if strengthened as shown at

detail No. 102 at A; and for light bearing timbers in roofing (especially the ridge), the form of joint shown in detail No. 102 at B is most common, secured by two ½" bolts.

The most generally accepted form of scarf for a "beam"—*e.g.* a purlin—is that shown in detail No. 102 at C, which allows for wedging up closely and bolting—one bolt on each side of the wedges. This scarf has no satisfactory scientific basis, but has been much used in good practice.

267. Purlin bearings on thin walls. Where no necessity arises for keeping the purlins in one line from end to end of a roof, they



are placed chequerwise on the supports as in detail No. 103 and bolted or spiked side by side if the supports are 4½" walls.

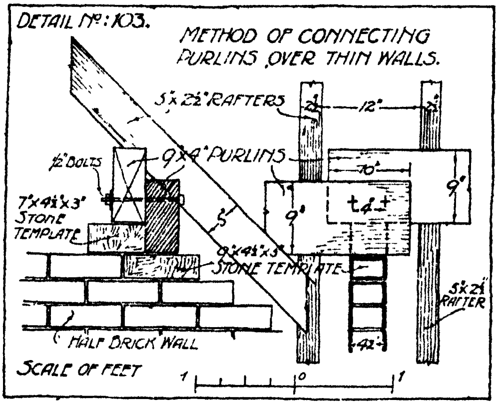
268. Special supports to purlins. In the long span of the roof purlin at detail No. 98 AA a post is carried up from the partition below, marked B. The scarfed joint previously referred to is placed immediately above this post as shown in detail No. 102. It is usually wise to arrange a scarf—where such cannot be avoided—over a suitable position for inserting a support.

Ceiling plan, detail No. 114, shows 4" × 4" posts in three positions for giving support to purlins and valley.

269. Joints of rafters to purlins, etc. To obviate the tendency of inclined timbers to slide downwards on a roof, they are secured in first class work by "birdsmouth notching." The form of notch

is illustrated in details Nos. 89, 92 and 100, which provides a "level bed" for the support of the rafter, and in deep rafters it reduces the distance through which nails have to be driven in securing the connection; 6" round wire spikes are chiefly employed for this purpose and should have a 3" "hold" in the purlin. Wall plate joints have been previously described and illustrated.

270. Chimney trimming. Detail No. 100 shows how the roof timbers are trimmed round the chimney stack. Two rafters, called trimming rafters, are placed near the edges of the stack—one on each side. A "trimmer," placed square to the roof surface and at least 1" clear of the stack, is framed between the rafters with pin mortice and tenon joints, secured in a similar fashion to the tusk tenon joint—see sketch on detail No. 100.



The intermediate rafters—named trimmed rafters—are dovetail notched to the trimmer in the same way as shown at detail No. 83 in floor construction. As an alternative they may be morticed and tenoned without the projection for the pin, and secured by nailing. This trimming is completed before the chimney stack is continued.

FRAMED OR TRUSSED ROOFS

271. When a building is wider than 18 ft. and longer than 16 ft. and without a cross wall which may be utilised to support the purlins, some other means must be provided to give the desired support.

This is provided by erecting trussed frames (or shortly, "trusses"), made to the shape of the roof, which are rigid and strong enough to span across the width of the building and transmit the load borne by the purlins it supports, to the external walls. Standing in vertical planes, these frames divide the length of the building into "bays" —rectangular areas crossed by purlins—whose length may con-

veniently be from 8 to 11 ft. and most commonly 9 to 10 ft. Purlins rest on the back of the frames and upon the gable wall, where such exists.

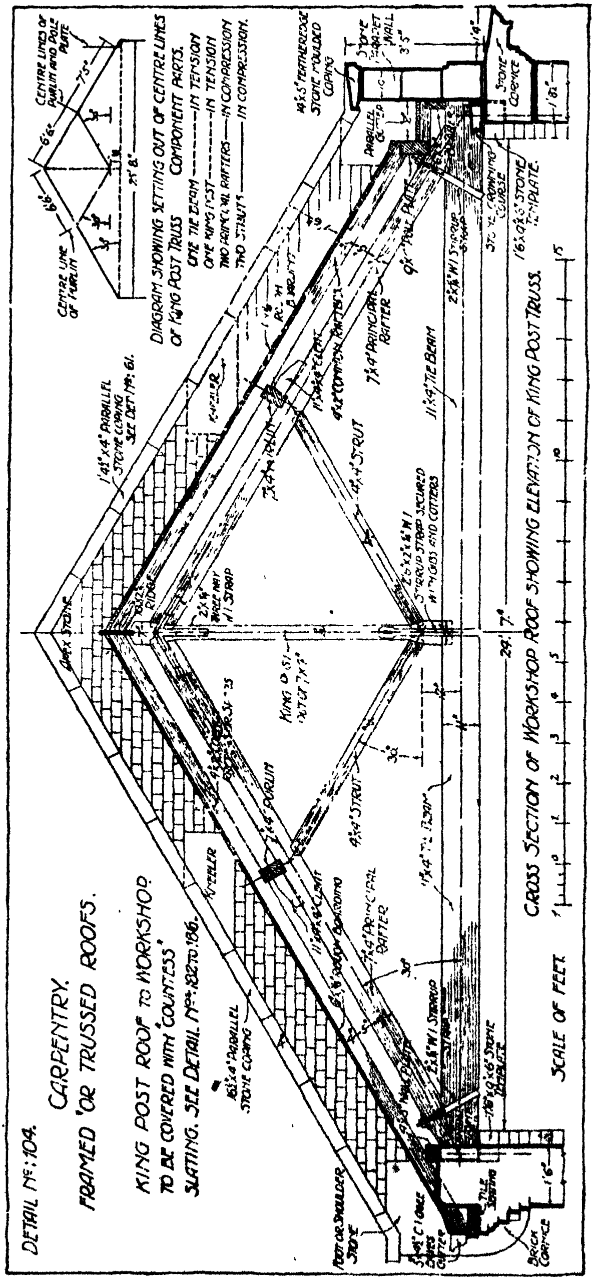
272. **Workshop roof.** A roof supported in the manner described is most suitable for the workshop we are detailing, because it has no division walls, and in this case the internal dimensions make the spacing of the frames suitably 8′ 3″ centres.

"Roof trusses" are often called "principals," and a roof in which any form of truss is used to support the purlins is called a "trussed roof." All trussed roofs consist of three sets of timbers, viz. common rafters, purlins and trusses.

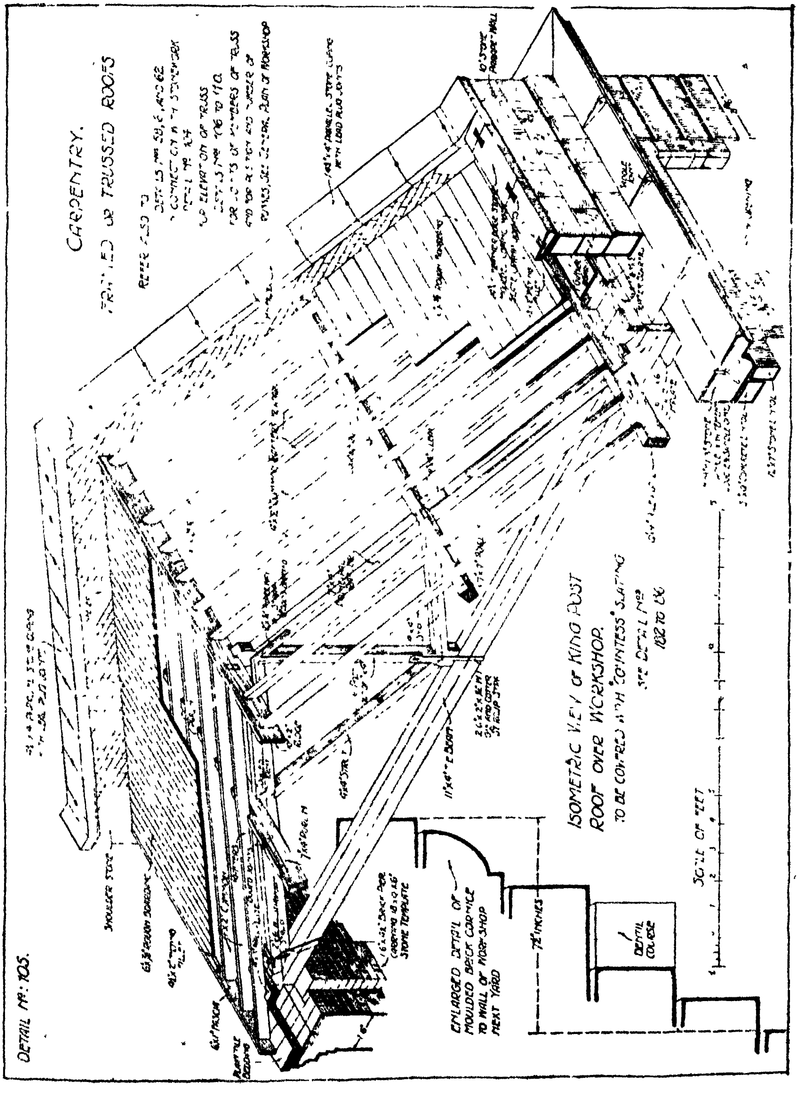
273. **Truss.** Trussed frames of any kind form a most important part of carpentry, and it is necessary to make clear exactly what is meant by the term. A "truss" is correctly any frame which is not easily deformable by reason of its outline being principally or wholly divided into triangles. The "theory" of trussing, or triangulating, properly belongs to the "mechanics" of building[1], but we may here point out the principles underlying the design of the workshop roof truss which is called a "king post" truss.—Details Nos. 104 and 105.

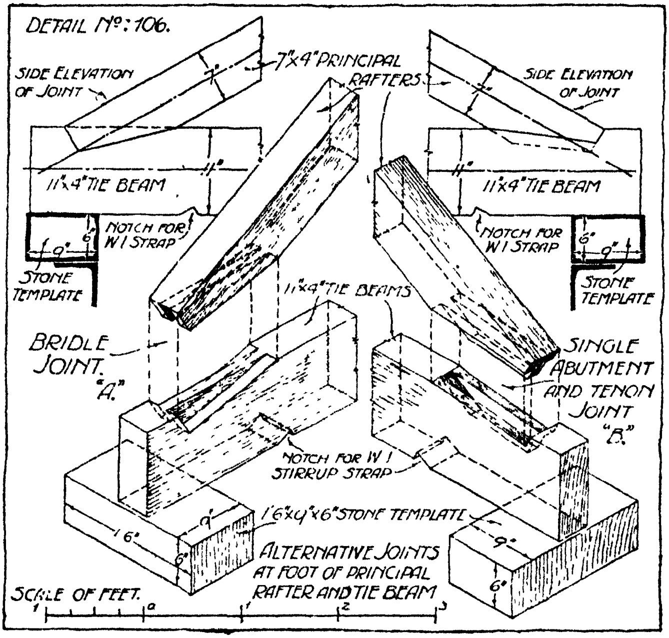
274. **King post truss.** In this case we have a span of 24′ 7″ clear between the faces of the attached piers which were provided for supporting the roof trusses. We desire to erect a triangular frame on which the *ridge* may be supported at the vertex, and the *purlins* on the two sides. These three members all bring load from the roof covering and rafters, and transmit it to the "principal." On receiving the load the first tendency of the two sides of the triangle would be to spread outwards at the foot, hence, with proper jointing the horizontal "base member" becomes useful as a "tie." The two sloping members are called "principal" rafters (to distinguish them from ordinary or common rafters) and the horizontal member a "tie beam." Rafters thrust downwards and are *compressed* while the tie is being *stretched* in its effort to prevent the movement of the rafters. The rafters are therefore in *compression* and the tie in *tension*. Suppose the frame is strong enough to support the loads, then, with merely rafters and tie, the purlins would cause the rafters to "bend," unless we used a very stiff member; we therefore provide a support at this point on each side by inserting *struts* inclined inwards and downwards towards the centre of the tie beam. If allowed to rest on the tie, they would make it "sag," or bend downwards, and let the rafters droop under the purlins, hence they are jointed into a "post" (king post) which is *suspended* from the head of the rafters,

[1] See *Building Science*, Vol. I, in this series.

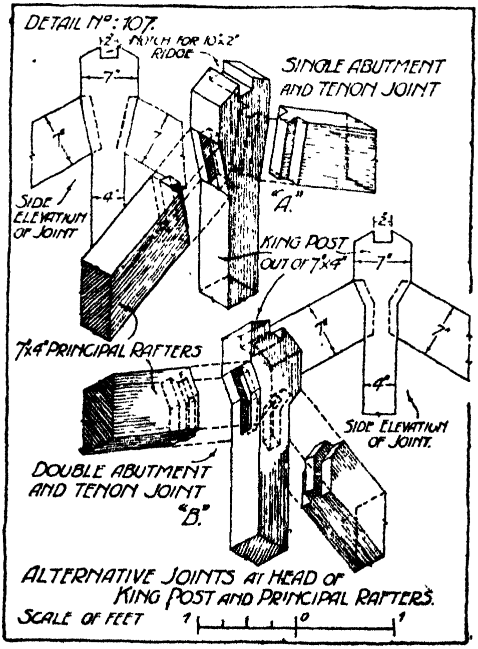

DETAIL No: 104.
CARPENTRY.
FRAMED OR TRUSSED ROOFS.
KING POST ROOF TO WORKSHOP
TO BE COVERED WITH 'COUNTESS'
SLATING. SEE DETAIL Nos. 182 TO 186.
CROSS SECTION OF WORKSHOP ROOF SHOWING ELEVATION OF KING POST TRUSS.
SCALE OF FEET.
DIAGRAM SHOWING SETTING OUT OF CENTRE LINES
OF KING POST TRUSS
COMPONENT PARTS.
ONE TIE BEAM — IN TENSION
ONE KING POST — IN TENSION
TWO PRINCIPAL RAFTERS — IN COMPRESSION
TWO STRUTS — IN COMPRESSION.

the struts entering its foot at a distance of at least 4″ from the top of the tie beam. Then, to prevent the tie sagging under its own weight it is hung up to the post by a bolt or strap. Struts are placed approximately at the centre of the length of the rafter but must not in any case be flatter than 30° (inclination to the horizontal) or they become very ineffective and difficult to joint.



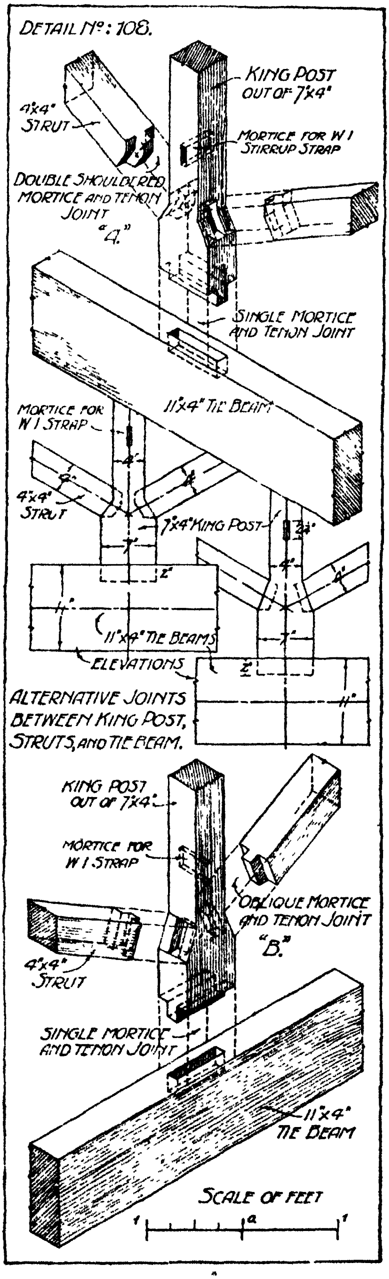


DETAIL No: 106.
SIDE ELEVATION OF JOINT
7"x4" PRINCIPAL RAFTERS
SIDE ELEVATION OF JOINT
11"x4" TIE BEAM
11"x4" TIE BEAM
NOTCH FOR W I STRAP
NOTCH FOR W I STRAP
STONE TEMPLATE
STONE TEMPLATE
11"x4" TIE BEAMS
BRIDLE JOINT. "A."
SINGLE ABUTMENT AND TENON JOINT "B."
NOTCH FOR W I STIRRUP STRAP
1'6"x9"x6" STONE TEMPLATE
ALTERNATIVE JOINTS AT FOOT OF PRINCIPAL RAFTER AND TIE BEAM
SCALE OF FEET.



DETAIL No: 107.
NOTCH FOR 10"x2" RIDGE
SINGLE ABUTMENT AND TENON JOINT
SIDE ELEVATION OF JOINT
"A."
KING POST OUT OF 7"x4"
7"x4" PRINCIPAL RAFTERS
SIDE ELEVATION OF JOINT.
DOUBLE ABUTMENT AND TENON JOINT "B."
ALTERNATIVE JOINTS AT HEAD OF KING POST AND PRINCIPAL RAFTERS.
SCALE OF FEET

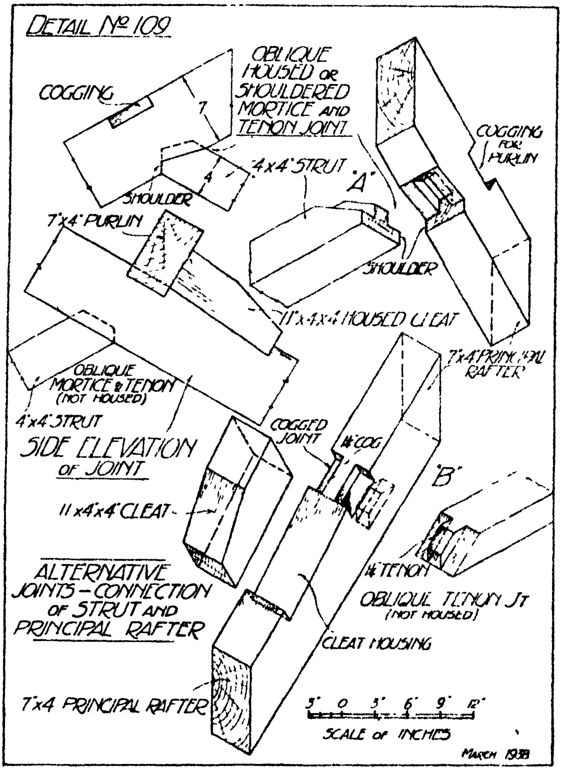
275. Centre line principle. Students who are studying "building science" will soon be able to realise that the most effective truss will be obtained when the centre lines of members grouped at a joint intersect in a point through which the load line or reaction line passes. This principle cannot *always* be successfully applied in timber structures.



276. Jointing of trusses. You should now examine the detail No. 104 carefully, and observe the provisions made for efficient jointing and support. The truss is 4″ thick in every part, and has 9″ minimum length of bearing on the walls. "Pad stones" or "templates" are provided at the bearings for spreading the load, as described in the chapter on Masonry.

The rafter feet are jointed by housing the rafter (7″ × 4″) into the tie beam (11″ × 4″) for a depth depending upon the type of joint employed. Two forms are available and illustrated at detail No. 106. At A is shown a "bridle" joint, in which the rafter is bridled over a tenon formed on the tie beam, and with a right-angled abutment. It is very suitable for joints occurring near the end of a beam. The joint at B is named a "single abutment and tenon" joint and is in common use for jointing inclined timbers. The abutting end or "shoulder" is made at 90° to the length of the rafter to ensure direct thrust. A minimum distance of 6″ from the

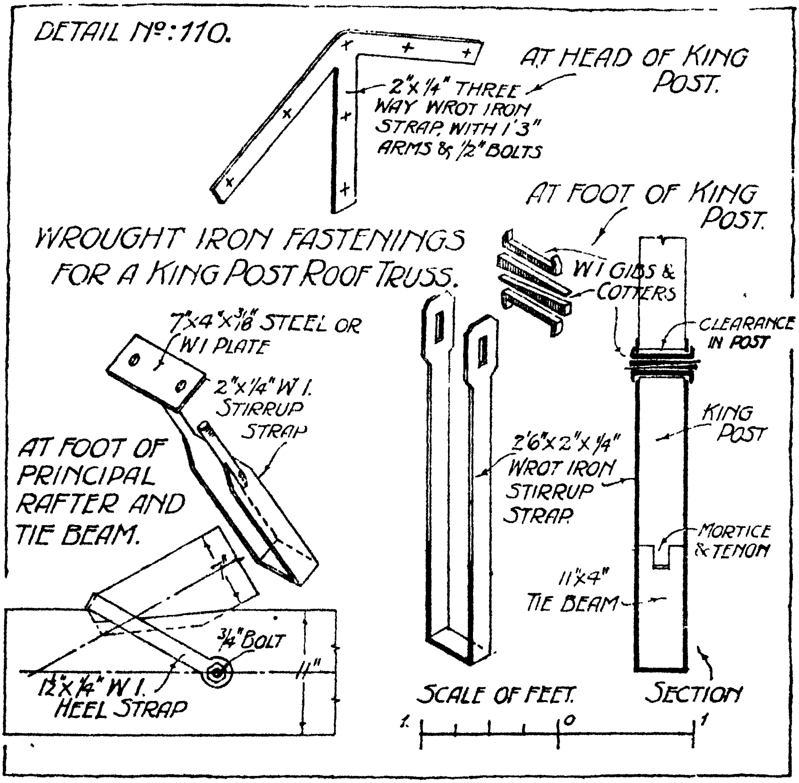
shoulder to the end of the tie beam is advisable to prevent the abutment being split off. To ensure strength, a wrought iron draw strap is clasped tightly by screwed nuts bearing on a plate across the rafter back. The draw strap is formed by welding $\frac{5}{8}''$ bolt ends to a W.I. stirrup, from $1\frac{1}{2}'' \times \frac{1}{4}''$ to $2'' \times \frac{3}{8}''$, and the back plate is $4'' \times \frac{3}{8}''$ to resist bending when tightened (detail No. 110). An alternative form of "heel strap," secured by a $\frac{3}{4}''$ bolt through the centre of the tie beam, is also shown. "Rafter heads" and "feet of struts" are connected similarly to the king post, which is broader at the extreme ends. It is reduced from 7″ to 4″ at the centre, to enable the oblique joints to resist sliding. The joints are all applications of the "oblique mortice and tenon joint," and named according to the exact form of the joint, *e.g.* "single" or "double" abutment and tenon. The *head* of the tenon and the mortice are at right angles to the side of the post as in details Nos. 107 and 108.



"Heads of struts" are *housed* and tenoned, except that the shoulder abutment is cut to a *vertical line*, to avoid displacement until loaded—see detail No. 109 at A. The joint at the "foot of the king post" is a single mortice and tenon about 2″ long—detail No. 108. The shoulders are $\frac{1}{2}''$ short when the members of the roof are assembled; the "stirrup strap" is drawn tight, lifts the beam close, and draws the ends inwards. This tightens up the joints of the truss due to "cambering" the tie beam, which in timber is necessary

owing to subsequent shrinkage, which tends to produce open joints and allows settlement of the whole truss.

277. Stirrup strap with gibs and cotters. The stirrup strap at the king post foot (detail No. 110) shows the arrangement of gibs (clip and bearing pieces) and cotters (wedges) for pulling the strap "upwards" and pushing the post "downwards." The joint is made with



clearances, space being left between gib and strap on the under side, and between gib and post above. Wedge pressure then lifts at the strap and thrusts at the post.

The slotted head of the strap must retain a cross section of $2'' \times \frac{1}{4}''$ ($\frac{1}{2}$ sq. in.) everywhere and have $1\frac{1}{2}''$ of length above the slot.

278. "Three way" strap and other metal connections. The use of the rafter foot strap is obvious when the joint is near the end, but it is necessary along with a "three way" strap at the head of the rafter

on each face. These secure the frame while lifting into position, since such trusses are assembled on the ground and lifted bodily into position.

Convenient dimensions of the head strap are 2" × ¼" × 15" along each branch, illustrated in detail No. 110.

279. Ridge and purlin joints. The ridge piece, 10" × 2", is supported during the erection of the rafters by a shallow slot cut in the head of the king post and in the correct position for setting the height of the ridge. The purlins, 7" × 4", are placed at 90° to the slope, cogged into the principal rafter, 1" deep, and prevented from tilting by cleats 11" × 4" × 4" bevel grooved into the rafter.

280. Common rafters, 4" × 2", are splayed or bevelled against the ridge piece at the head as in previous examples, and cogged 1" deep upon the purlins. In cheaper work cogging is omitted and the rafter nailed only to the purlins.

281. Feet of rafters and eaves finish. Two methods of finishing the roof at the foot are shown in details Nos. 104 and 105. On the left-hand side, adjoining the yard, the rafters overhang the main wall 6", and terminate on a five course "brick cornice" projected from the wall to carry the gutter, which rests directly upon an intervening tile course.

The cornice is an architectural feature, heavier than is "constructionally" necessary, and illustrates the mode of accomplishing such a projection. This cornice and tile course rise 3" above the top of the stone template course and the eaves finish is then produced by the following arrangement: rafter feet are neatly cut to the 6" projection, the roof "close boarded" with 6" × 1" square edged fir boards, finished with a "tilting fillet." The latter is a splayed "starting piece" to the slope, out of 4½" × 2", giving a tilt to the slates which you will find necessary when bedding the lower courses; see Chapter Sixteen, detail No. 183.

282. Fascia and eaves gutter. A "fascia board," 6" × 1", covers the rafter ends and the edge of the tilting fillet, to both of which it is firmly secured. The remainder of the "ledge," 2" to 3" wide, provides a seating for the cast iron ogee gutter which is 5" wide by 4½" deep. For methods of securing see Chapter Seventeen.

In the best work a piece of lead would be dressed 2" over the tilting fillet, copper nailed along the edge, brought down the fascia, across the brick edge and 1" down the face of the brickwork. This prevents percolation of rain water into the brick cornice, caused by driving

rain and leakages. Beam-filling is not intended here, the wall being finished at the level of the top of the tie beam in order to receive the wall plate. This is not advocated as an ideal finish but illustrates an alternative to beam-filling which is often adopted in workshop and warehouse buildings and with modifications in church roofs.

283. Parapet gutter. The right-hand side of the roof in details Nos. 104 and 105 has quite a different finish. In the section on Masonry we noted how the side wall was terminated by a stone cornice, capped with a stone parapet. The section of detail No. 104 shows this parapet, with the woodwork of the roof finishing behind it in the form of a gutter of "parallel width," which is to be lined with lead. The gutter is to be formed of wood, 12″ wide and deep enough to allow of sufficient "drips" and "fall" in the length; see chapter on Plumbing, details Nos. 185 and 190.

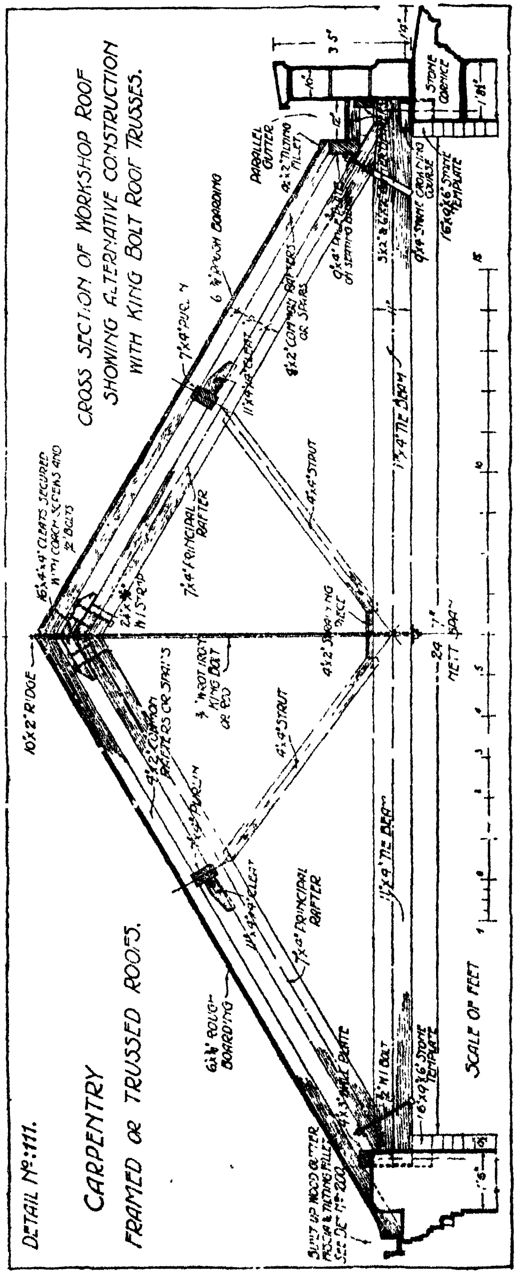
For the purpose of forming the side of the gutter, and at the same time supporting the rafter feet, a 9″ × 4″ horizontal timber is set on edge, resting upon the principal rafter and packed up by a seating block if necessary. It is called a "pole plate" and derives no support from the wall. Against the parapet, a 6″ × 2″ longitudinal bearer is laid on edge, supported by the ends of the tie beams. Short gutter bearers, 3″ × 2″ and 12″ apart, are tenoned to the pole plate and notched upon the wall bearer at different levels, in order to obtain the necessary fall and drips at the gutter.

The gutter base is then formed of 6″ × 1″ dressed boards, laid lengthwise. For leadwork see details Nos. 185, 187, 188 and 190.

284. King bolt truss. Timber roof trusses are particularly suitable for attaching ceilings to their tie beams, ceiling joists being fixed at 90° to them. There is no ceiling in the workshop, but the timber tie beam is used for this structure.—See detail No. 111.

It was shown that in the king post roof truss, the rafters and struts were "compressed" while the king post and tie beam "extended" under the weight of the covering.

Now wrought iron is very strong compared with wood and will safely withstand a pull of five tons per sq. inch. Hence a small rod would often serve the same purpose as a large wooden member if the tendency is to extend it, and under some conditions both tie beam and king post may be replaced by a "tie rod" and "king bolt." With this form of truss, keeping wooden struts in the same position, a difficulty would arise in jointing the struts on a metal tie, and we have therefore retained the timber tie and adopted a king bolt only. The "principal" is then called a "king


DETAIL No. 111.
CARPENTRY
FRAMED OR TRUSSED ROOFS.
CROSS SECTION OF WORKSHOP ROOF
SHOWING ALTERNATIVE CONSTRUCTION
WITH KING BOLT ROOF TRUSSES.
10"x2" RIDGE
7"x4" PRINCIPAL RAFTER
11"x4" TIE BEAM
4"x4" STRUT
¾" WROT IRON KING BOLT OR ROD
STONE CORNICE
SCALE OF FEET

bolt" truss. It is "composite" in character because two materials have been employed for principal members.

Detail No. 111 shows how the joints are made. Centre lines of members are made to intersect at a common point as in the wooden truss, and the method of securing the heads of the rafters is as follows: A wrought iron head strap $2\frac{1}{4}'' \times \frac{3}{8}''$ is bent as shown, the rafter heads fitted abutting on each other, with a flat top cut on each about 3" wide. The strap is bolted and coach screwed to each rafter and the king bolt passed through a hole in the centre of the flat top. To support the ridge, notched cleats are fixed by the bolts used to secure the rafter and plate. The feet of the struts are placed where required to maintain the centre line intersection of the members, and kept apart by a distance or straining piece 2" thick, spiked on the tie or housed into it $\frac{3}{4}''$ deep, and the struts tenoned $1\frac{1}{2}''$ into the beam. The resulting "principal" is excellent—a great improvement on the king post and nicely adjustable for tightening the frame.

285. Porch roof and framing. A roof is sometimes conveniently flat, or nearly so, as for example in roofs to bay windows, and we find it convenient to employ a flat roof to the porch at the cottage entrance; see sketch detail No. 112.

The roof is suitably covered with lead and the woodwork specially prepared to receive it; we shall study the construction of the woodwork of roof and supports here, and leave the leadwork to its proper sphere in the chapter on Plumbing.

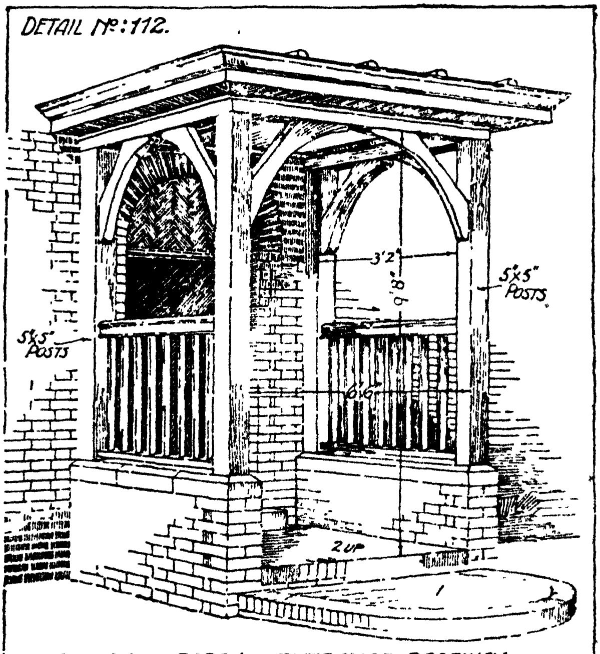
We might note in passing that some portions of the timber work in this structure are properly carpentry while others (the decorative portions) may be looked upon as joinery. It is convenient, however, to describe the whole structure under one heading.

The general appearance of the porch is shown in perspective detail No. 112, which also contains the chief dimensions.

286. Framework. Consider detail No. 113. The framework of the porch consists of four $5'' \times 5''$ oak posts, resting upon "stone capped" brick bases to which they are dowelled with $1\frac{1}{4}''$ square wrought iron or copper dowels 4" long. Two posts are placed close to the wall; these posts carry a $5'' \times 5''$ oak "head rail," to which they are stub tenoned, the tenons being $2\frac{1}{2}''$ square and $\frac{7}{8}''$ long. The "head rails" at the sides are built $4\frac{1}{2}''$ into the wall to give rigidity to the porch sidewise, and are wedged tight before the roof is covered.

At the front angles, the side rails are double haunch tenoned to the "front head" and this rectangle forms a framework on which the joisting for ceiling boards and leadwork is laid.

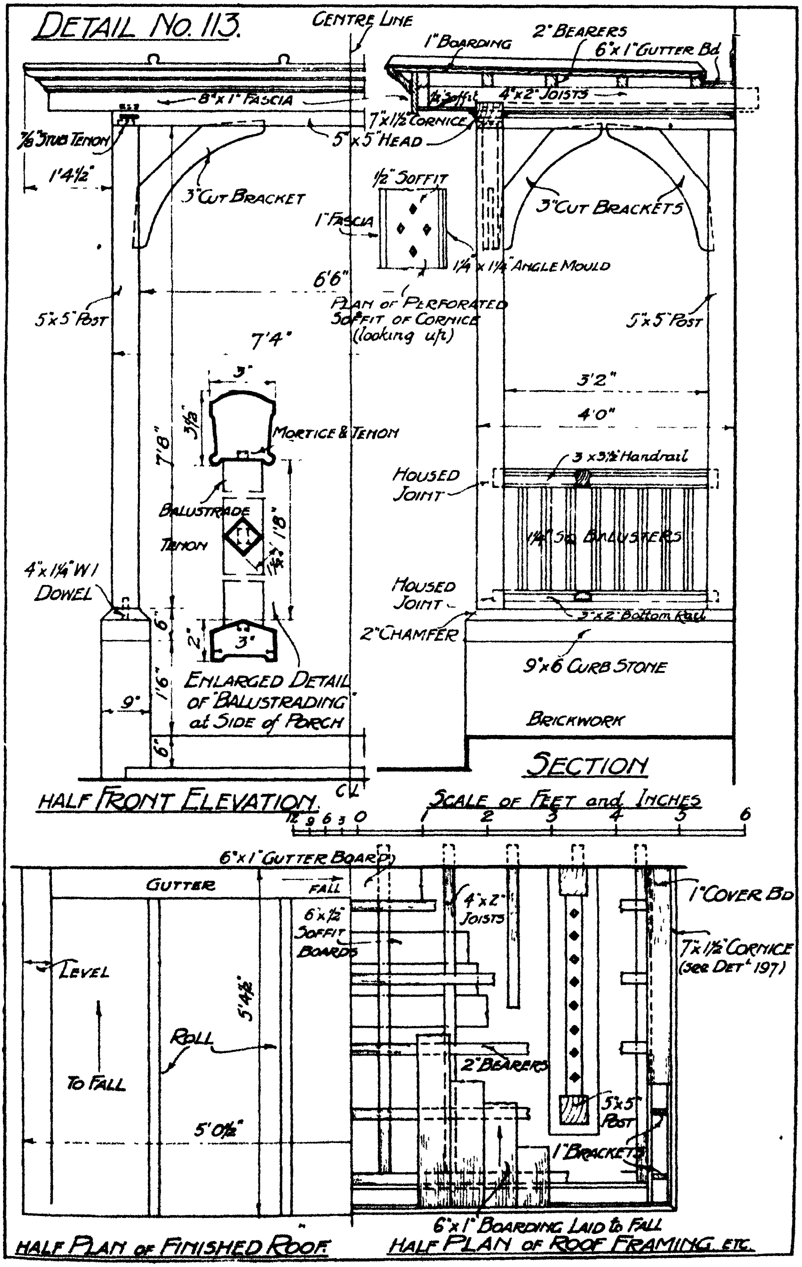
287. Roof. We desire that the "flat" shall have a fall towards the main wall, terminating in a shallow gutter there. The ceiling must remain level for the sake of internal appearance, hence two sets of timbers are required, the first, of 4" × 2" joists laid at 90° to the wall, built therein and resting on a $2\frac{1}{2}$" × $\frac{1}{4}$" W. I. plate, and notched $\frac{3}{4}$" over the "front head" with a projection of 9" beyond it to carry the moulded cornice. This projection is required at the front and sides of the roof and is finished to receive the cornice by placing



SKETCH OF PORCH TO ENTRANCE DOORWAY OF COTTAGE.

a 4" × 2" joist across the front and ends, dovetail "tenoned" at the outer angles and dovetail "notched" to each intermediate joist. A level framework is thus produced, ready to receive ceiling boards on the under surface and $\frac{1}{2}$" soffit boarding at the overhanging margin, and also to carry lighter joists above, on which the "leadwork boarding" may be laid. The soffit boarding is wisely perforated at intervals by groups of diamond-shaped holes to afford ventilation to the enclosed timber.—See detail No. 113 at A.

It is always desirable that the boarding of a "flat" shall have its grain in the direction of the current, so that any inequalities due to the boards warping may not interfere with the flow.


DETAIL No. 113.
CENTRE LINE
1" BOARDING
2" BEARERS
6"x1" GUTTER Bd
8"x1" FASCIA
½" Soffit
4"x2" JOISTS
7"x1½" CORNICE
⅞ STUB TENON
5"x5" HEAD
1'4½"
3" CUT BRACKET
½" SOFFIT
1" FASCIA
3" CUT BRACKETS
1¼"x1¼" ANGLE MOULD
6'6"
PLAN OF PERFORATED SOFFIT OF CORNICE (looking up)
5"x5" POST
5"x5" POST
7'4"
3'2"
3"
4'0"
3½"
MORTICE & TENON
7'8"
3 x 3½ Handrail
HOUSED JOINT
BALUSTRADE
1'8"
TENON
1¼" Sq. BALUSTERS
4"x1¼" W.I. DOWEL
HOUSED JOINT
6"
2"
3"
3"x2" Bottom Rail
2" CHAMFER
9"x6" CURB STONE
1'6"
ENLARGED DETAIL OF "BALUSTRADING" at SIDE of PORCH
9"
BRICKWORK
6"
SECTION
HALF FRONT ELEVATION.
C L
SCALE OF FEET and INCHES
12 9 6 3 0 1 2 3 4 5 6
6"x1" GUTTER BOARD
GUTTER
FALL
1" COVER BD
4"x2" JOISTS
6"x½" SOFFIT BOARDS
7"x1½" CORNICE (see Det. 197)
LEVEL
5'4½"
ROLL
TO FALL
2" BEARERS
5"x5" POST
5'0½"
1" BRACKETS
6"x1" BOARDING LAID to FALL
HALF PLAN OF FINISHED ROOF
HALF PLAN OF ROOF FRAMING, ETC.

288. Firring. The small joists on which the 6″ × 1″ boarding is laid—called firring—must therefore be at 90° to the flow, and further must be varied in depth, so that when correctly spaced—12″ apart approximately—the boards laid upon them have the required fall.

289. Fall. The fall of a flat should be at least 1½″ in 10 ft. and may be usefully twice that amount; we have allowed 1¼″ in 4′ 9″ here, starting the fall from the level of the cornice at the front edge.

290. Gutter. To form the gutter, the first firring joist is laid 6″ to 8″ clear of the wall and is made at least 2″ deep, so that when a 1″ gutter board is laid on the lower series of joists and packed to a fall, in order to discharge to one end, it has a clear depth of 2″ there. Very shallow gutters should be avoided, especially when draining larger areas.

291. Decorative features. We may now refer to the remaining features of the porch in completion of our study of the structure. The "cornice" is intended to form a screen to the flat, as well as a crowning feature to the porch.

Observe that it is formed of a deep fascia 8″ × 1″, tongued soffit boards ½″ thick, and a crowning moulding 5″ × 4½″. These are shown clearly in detail No. 113, section at B, the members being mitred at the external angle and neatly nailed in both directions from the faces.

The crowning mould is of thin material (1½″ × 7″) and fixed on the rake to triangular packing pieces, or brackets, secured to the fascia, as in the isometric detail. The hollow back of the mould is then covered by the "lead boarding" at the front, and a "cover board" at the sides, over which the lead is dressed, thus protecting the joint. A rebate in the top of the cornice mould receives the square edge of the capping.

292. Brackets. To give rigidity to the connection between posts and roof, and to add to the decorative value of the structure, pairs of "curved brackets"—with straight backs—are cut and fitted in the angles between "head" and "post," on each face. Being obtained from broad material, 8″ × 3″, the oblique cuts forming the right angle result in long joints which, if tenoned or housed, or both, and made from dry, well-seasoned material well secured, produce very rigid angles. An "oblique tenon or tongue" is shown in detail at C. In oak work, the tenon is advisedly made 2″ long and secured by "oak pins," ⅜″ diameter, through the face of the post. Nails may be used for securing "deal" brackets, but should not be employed for oak, owing to the rapid oxidation caused by the acid it contains.

293. Screen rail and balusters. Additional "screen" to the main doorway is secured by filling the lower spaces between the side posts with plain diagonal balusters framed between a "handrail" and "base or bottom rail" as shown in details Nos. 112 and 113. The moulded oak handrail, $3\frac{1}{2}'' \times 3''$, and weathered base, $3'' \times 2''$, are housed 2″ into the posts, and the balusters, $1\frac{1}{4}''$ square set diagonally, are tenoned and scribed to the cill. They must fit closely and be set in white lead to prevent rain water soaking into the mortices.

Drips are formed to the under surfaces of handrail and base piece, for reasons explained in previous chapters.

294. Material. The whole of the visible parts of this structure are advisedly of oak, and in any case the posts, rails, and balusters should be of this material to resist the effects of exposure.

295. Preparation of joints. In assembling the parts of any piece of external carpentry and joinery, it is wise to prepare the joints accurately and to paint them, before finally placing them in position and securing, with "white or red lead and oil" paint. Joints in "deal" work may be painted with thin red lead and oil, allowed to dry, then repainted, drawn close and fixed.

Oak, if to be left natural colour and oiled, must not be disfigured at the joints; it should be painted with "boiled linseed oil" only, allowed to dry, then recoated, assembled, and pinned securely.

296. Detail of oak structures. In designing oak structures it is wise to adopt a studied simplicity of detail, any decorative value being embodied in the "outline of the mass" and in suitable choice of "grain" in the members.

CHAPTER TEN

PERMANENT CARPENTRY

Ceilings and Partitions

297. Ceiling is the name applied to the "overlay of plaster," or other covering, closing in the top of a room or enclosed area, and to its "supporting woodwork." We are concerned here with the supporting timbers to which the "laths" are nailed.

298. Ceilings attached to floors. It has already been noted that floor joists are made to serve for the support of ceilings wherever such arrangement is convenient.

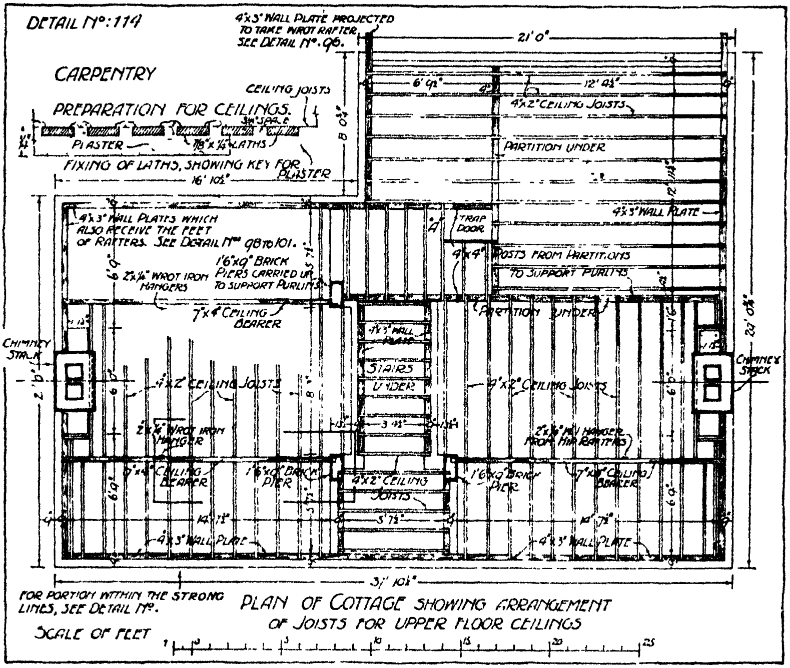
299. Bedroom ceilings to cottage. Ceilings to bedrooms of cottage cannot be so attached and therefore require special timbers called "ceiling joists" placing in position, of suitable size and disposition for carrying the plaster ceiling.

Details Nos. 99, 114 and 115 studied together will make the construction clear. No. 99 gives a cross section of the roof and No. 114 a complete plan of the bedroom ceiling joists. No space is provided for use within the roof space, and ceiling joists are therefore placed from wall to wall at the level of the wall plate, notched thereto and made to span the whole room in one length. The only openings through the ceilings are "access openings" about 2′ 2″ square, often called "traps," which provide access to the roof interior for inspection and repair purposes. These access openings are made in inconspicuous positions and one may be made to serve for the whole building if openings be left in the gables of the brick division walls between the rooms. For example see A, detail No. 114.

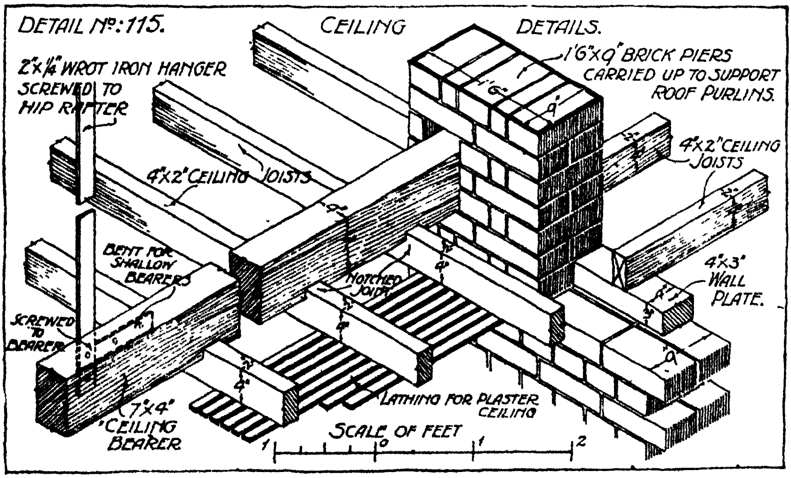
300. Trimming. Openings in ceilings and disposition of joists round chimney breasts are treated by trimming the timbers in a similar manner to floor joists and roof timbers using "dovetail notches" or "mortice and tenon" joints.

301. Support of joists over long spans. As ceilings are quite distinct from each other in our example, being contained between walls, the joists may be placed in "either" direction to utilise the shorter span, or to suit any other convenience.

But the span for light ceiling joists—usually not larger than 4″ × 2″—is often excessive, as will be clear from detail No. 114, and when this occurs the joists are supported at intervals to prevent sagging. One method, see detail No. 99, is to introduce 7″ × 4″ bearers resting on the walls, as shown over the larger bedrooms. The



PLAN OF COTTAGE SHOWING ARRANGEMENT OF JOISTS FOR UPPER FLOOR CEILINGS

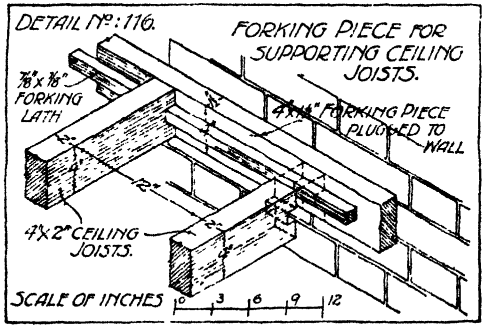


joists are notched to them and "firmly nailed on the splay" to assist in avoiding their withdrawal under the load of the ceiling.

Another method of providing for the intermediate support of ceiling joists (see detail No. 115) is to use a bearer, say from 3″ × 3″ upwards, well nailed to the top of the joists across the width of the room and to hang this bearer up at intervals by 2″ × ¼″ flat iron bars suspended from the roof timbers, *e.g.* purlins and ridge. The bar may be bent at the bottom end as shown at detail No. 115 and "screwed" or "clout nailed" to the bearer and purlin; the purlin requires to be a little deeper than usual when called upon to suspend the ceiling.

Whatever method be employed, the closer the bearers and the lighter may be the ceiling joists employed; the average size is 4″ × 2″, but 3″ × 1½″ are quite common.

302. Staircase ceiling. The ceiling joists to the staircase rest directly upon the walls and are built in as the work proceeds. Should it be desired to fix them later, holes may be left in the heading courses of the walls, joists inserted at the carpenter's convenience, wedged tight and the holes stopped.



As an alternative the ceiling joists may be supported on "forking pieces" and "laths" as per detail No. 116, a method very common in the North of England. Forking pieces, 3″ × 1″ to 4″ × 1½″ (really "bearers"), are secured by plugging firmly to the walls. A ⅞″ square lath—called a "forking lath"—is well nailed to this and the joists are "forked" or "bridled" over it and skew nailed. If this method is used for spans over 8 ft., intermediate support must be provided; otherwise the joists are liable to split horizontally along the fork.

303. Back bedroom and bathroom. Advantage is taken in the ceiling of the "back bedroom" and "bathroom" to carry the ceiling joists across the full length of the two rooms, thus deriving intermediate support from the partition between them and rendering the joists much stronger by their conversion into continuous beams. Although the span of this room is 12′ 4½″ no further support is required.

304. Spacing of ceiling joists. The distance between ceiling joists depends upon the strength of the laths employed to support the plaster.

The average spacing in good work is 10″ to 12″.

PARTITIONS

305. Partitions are vertical divisions or screens, cutting up the floor space of a building into a series of rooms of convenient size and shape.

They may continue through two or more "storeys," and if required to give support to roof and floor timbers must be of adequate strength for the purpose.

306. Kinds of partitions. Brick is in general use for ground floor partitions and for those more than one storey in height, viz. where the division of the upper floor coincides with a lower one. Brick partitions are commonly 4½" thick, but if more than two storeys in height are unsatisfactory. In any case they should receive assistance to prevent side movement if more than 10 ft. high. Floor and ceiling joists serve this purpose, and increase stability by adding weight so long as the wall remains truly vertical. See chapters on Brickwork for the construction of these and thicker partition walls.

307. Special forms. Special and modern forms of partition such as terra-cotta blocks, concrete and plaster slabs, concrete "in mass," steel corrugated sheeting, expanded steel, etc., although often simple in construction, are applied more particularly in larger buildings and under special circumstances. They will be treated in a later volume.

308. Timber partitions. Timber-built partitions are an old type, still in common use and very convenient for dividing floors into different plans in successive storeys.

There are three kinds of partition in which timber is a principal factor.

(*a*) "Common," "quarter," or "stud" partition. (Called a "stoothed" partition in some parts.)

(*b*) "Trussed" or "braced" partition.

(*c*) "Bricknogged" partition.

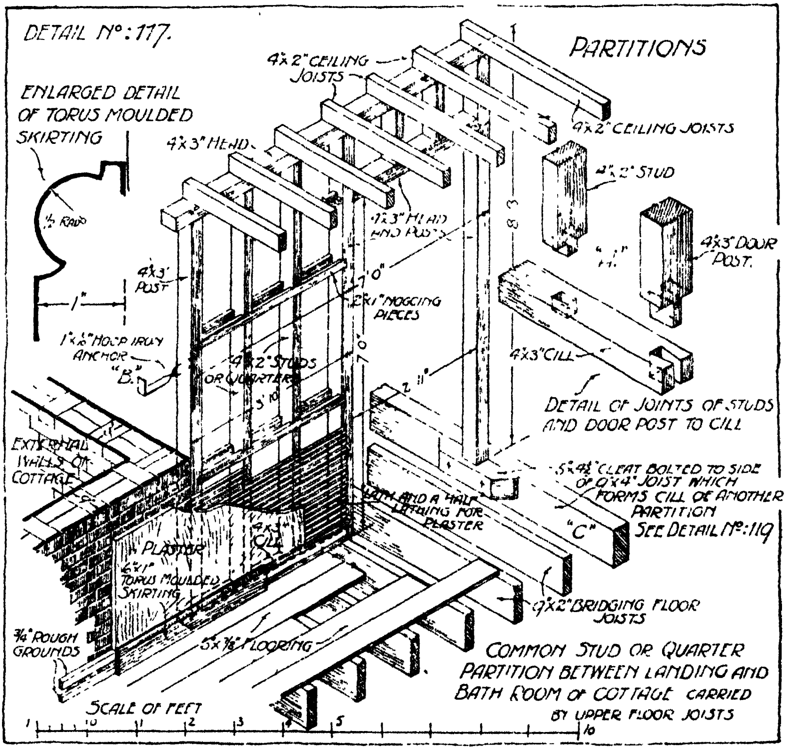
309. Stud partitions. Stud partitions consist of an assemblage of timbers carried entirely by the floors on which they are erected, the floor being sometimes strengthened by a larger joist when the partition is parallel to its direction and immediately above it.

These partitions are intended to be supported throughout their entire length, and are employed chiefly in dwelling houses on upper floors. They consist of a cill, head, door posts (where an opening is required) and studs or "quarters."

Studs are light vertical timbers, 3" × 1½" to 4" × 2", which are framed between the "head" and "cill" of the partition, at an average distance of 12" apart and form the "body" of the partition. "Door

posts" are specially strong studs forming the sides of a doorway and affording a rigid groundwork to which door frames and finishings may be secured. "Head" and "cill" are pieces of varying size, laid across ceiling joists and floor respectively and must be thick enough to joint the studs satisfactorily thereto.

Members of partitions should not be of excessive width because they interfere with the "key" of the plaster.—See detail No. 114.



310. Bathroom partition. An example of a stud partition occurs in dividing the bathroom from the landing in cottage. No wall exists on the floor below which might have been carried upward for the purpose, hence timber is used.

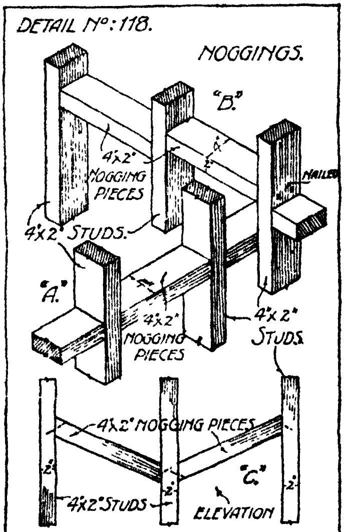
On examination of the plan it will be seen that this partition is contiguous to another partition dividing the bathroom from the back bedroom and at right angles to it; see general plans of cottage. In connection with the larger partition (detail No. 119) a cill, 9" × 4", takes the place of a 9" × 2" floor joist as shown also at "C" in detail No. 117. This provides a suitable base for supporting the right-hand door post. A seating is formed by a 5" × 4½" cleat about 1' 9" long,

bolted to the cill by two 7½″ × ½″ bolts and the 4″ × 3″ door post is tenoned into it.

A ledge 1½″ wide is thus available to carry the edge of the floor board at the doorway.

On the left of the doorway we have a length of partition, 3′ 10″ wide, which is constructed as follows: on the floor joists is laid a 4″ × 3″ "cill" and upon this are erected 4″ × 3″ "door" and "wall" posts and 4″ × 2″ "studs" jointed as illustrated in sketches at detail No. 117 at A. For the end posts a "dovetail tenon" is employed and for the studs a short "mortice and tenon." A 4″ × 3″ head spans the length of the partition, enters the wall 4½″ at the left, is tenoned to the head of the larger cross partition and has the studs and posts connected to it by mortice and tenon joints, as at the cill. To form the correct height of door opening a "door head," also 4″ × 3″, is "bevel housed" between the posts and morticed and tenoned and "pinned," as in detail No. 123. Short studs fill the space above the door head and complete the framing.

311. Securing wall posts. Observe that the wall posts may be further secured to the wall by anchors of hoop iron nailed to their wall faces, bent back at 90° for a length of 4½″ (or 9″), and back again parallel to the post for a length of 3″. These are shown in position at detail No. 123, walled into the brickwork during its progress and ensuring a rigid post. An alternative arrangement, allowing the post to be erected after the building is completed, is shown at B, No. 117.



ALTERNATIVE FORMS FOR SECURING NOGGING PIECES TO STUDS OF TIMBER PARTITIONS.

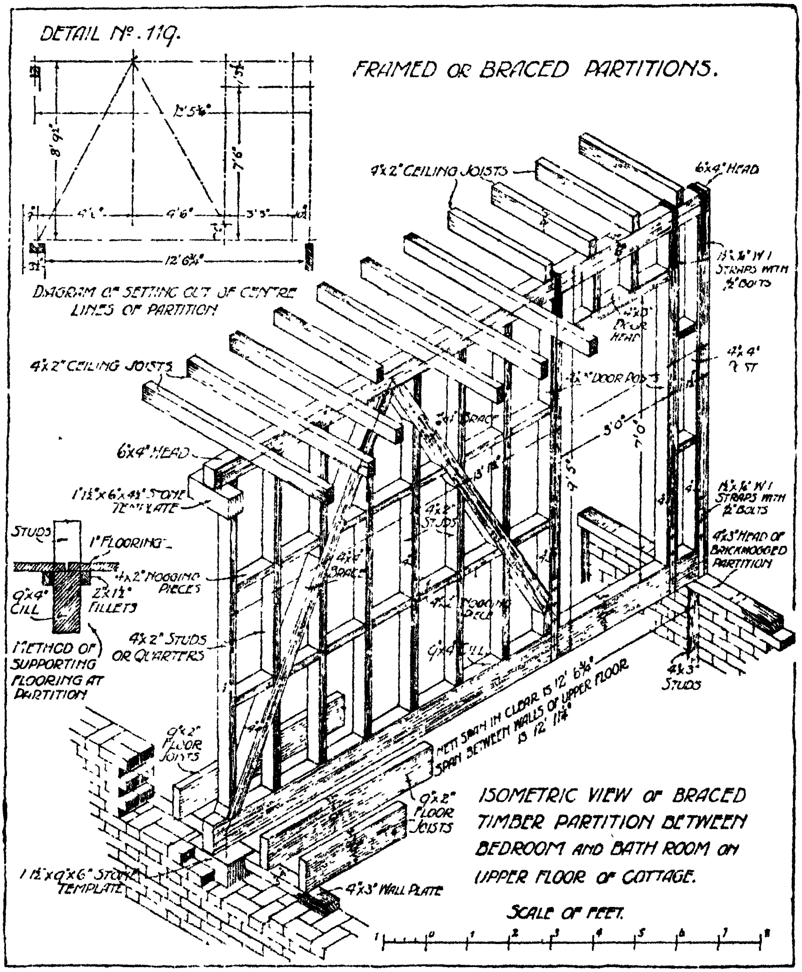
312. Long studs and nogging pieces. Long studs cause a partition to lack rigidity because pressure on any part of the plastered surface would be borne by one or two studs, hence they are connected to each other by horizontal pieces called "noggings," at heights advisably not greater than 3′ 6″.

"Noggings" may consist of:

(*a*) 2″ × 1″ strips notched into the faces of the studs and dovetail nailed, as in detail No. 117.

(*b*) Short lengths of 4″ × 2″ stuff may be cut to fit tightly between the studs and placed in one line as in detail No. 118 at A.

(*c*) For convenience of nailing they may be placed chequer-wise or inclined, as in detail No. 118 at B and C, and nailed through the stud or the nogging piece as shown. Type "*b*" is the "stiffest" if well done, though "*c*" is also good; "*a*" weakens the studs unwarrantably and is laborious to execute.



313. Trussed partitions. Trussed partitions are used, (*a*) where there is some probability of side disturbance; (*b*) where the partition is desired to carry its own weight and possibly the weight of floors and ceilings.

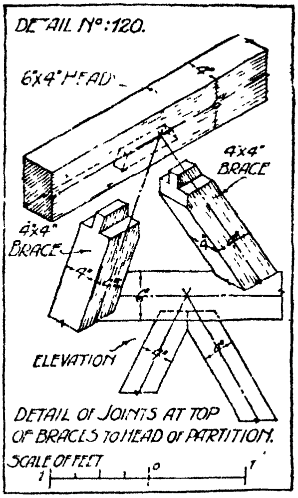
In detail No. 119 we desire the partition to carry its own weight,

to assist in carrying the stud partition last considered and also to support the bedroom ceiling joists previously referred to.

314. Trussing. Trussing, as before explained, involves triangulating with "horizontal," "inclined," and "vertical timbers," and our object here is to transmit the weight to the walls with the least possible change in the shape of the frame.

In this partition we have a doorway on the right, entering the bedroom at a distance of 9½″ from the support, hence all triangulating must be done in the large rectangular space between door post and left-hand support.

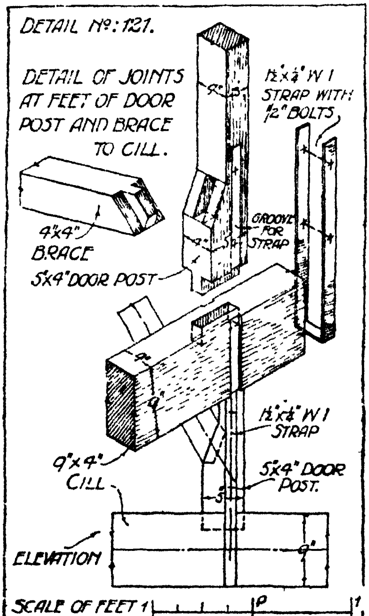
315. Construction. The structure is built up as follows: A cill, 9″ × 4″, spans from wall on the left to bricknogged partition on the right. Notice that a "stone template" is provided at the wall bearing, and a "post" is placed immediately under the "cill bearing" in the bricknogged partition below. Upon the cill, a 4″ × 4″ wall post and 4″ × 3″ door posts are erected, and on these again a 6″ × 4″ head; two 4″ × 4″ inclined braces meet under the head at the centre of the large opening (shown dissociated at detail No. 120) and act as struts transmitting load from the structure, to the "cill bearing" at the left and to the "door post" on the right. The latter is treated like a "king post" in a roof truss, the door post being cut from 5″ × 4″ material and reduced to 4″ × 3″ above the joint. Details of these and the brace joints at the foot are given at Nos. 121 and 122, all being variations of the oblique mortice and tenon, or of the oblique bridle joint.

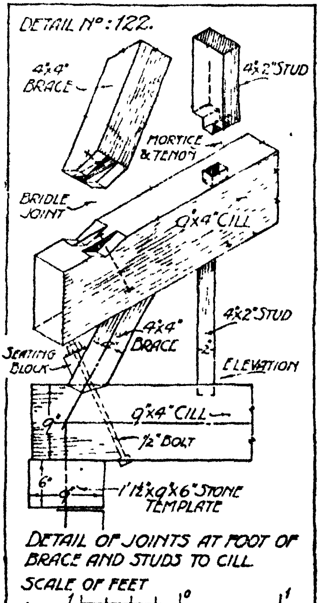


316. Suspension of cill. To ensure that the load on the cill—caused by its supporting the triangular area of partition between and below the struts—does not cause it to "sag," the cill is suspended from the posts by 1½″ × ¼″ W.I. straps, fixed by ½″ bolts through the post, as shown in detail No. 121. Gibs and cotters for lifting the joint close would not be practicable here; they project too much. The cill is therefore forced tight at the shoulder by any temporary means, and the bolts inserted while close. Any subsequent tightening required, owing to shrinkage, may be accomplished by driving pairs of thin oak or iron wedges between the strap and the cill. Oak wedges are preferred; they may be "bradded" to prevent displacement after tightening.

317. Headstraps. It will be seen that straps are used at the "heads" of the posts in addition to the "feet." These cause the head and cill to act together, thus utilising the value of the depth of the partition to obtain a rigid frame; they also help to maintain the rectangular form of the doorway.

318. Centre line setting-out. We have previously referred to the usefulness of "centre line setting-out" of trusses. These principles are not always attainable in timber work owing to difficulties of jointing, one case of common failure being the intersection of the centre line of





strut and post at a doorway. In our example these should theoretically cut at the centre line of the cill, otherwise bending of the post is induced. If two such struts abut on the post as in the king post truss, their thrusts neutralise each other and merely cause pull on the post.

This difficulty might be overcome by placing the foot of the strut in the angle of cill and door post, but shrinkage of the cill and post then causes undue settlement by lowering the brace bodily. For the setting-out adopted in our example see line diagram, detail No. 119.

319. Filling. To complete the partition, studs and nogging pieces are inserted as in "stud partitions," the studs being splayed and nailed against the braces where they intersect. Study the detail for further comparisons.

320. Floor boards at partition. The ends of floor boards at the trussed partition are carried by 2″ × 1½″ bearers spiked to each side of the cill, the boards continuing over the latter where the studs do not interfere. This is shown in section at the left of detail No. 119.

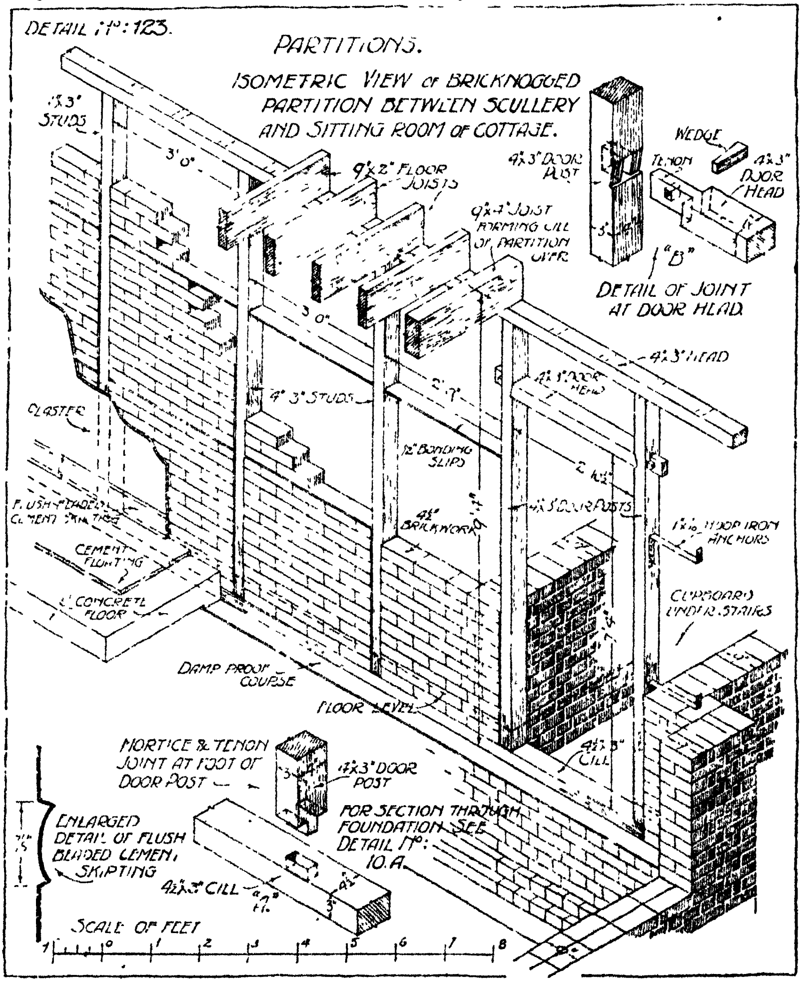
321. Bricknogged partitions. We have seen in the previous description that noggings of wood are employed to stiffen stud partitions and have now to explain that brickwork may be used for the same purpose. Half-brick walls are weak in large areas, but rigid enough in small ones, hence "timber framed partitions," with the studs widely spaced to suit a number of brick lengths, are often filled with panels of brickwork which act as nogging and sound proofing. Horizontal strips of wood are also introduced at intervals of 2′ 6″ to 3′ in height to tie the courses lengthwise.

322. Disadvantages. Bricknogged partitions have the serious disadvantage of possible inducement of decay, which is intensified by the use of unseasoned timber coming into contact with wet mortar, and sometimes covered by plaster before the moisture has evaporated. If employed, dry, well seasoned timber of mature growth should be used; then, though some moisture will necessarily be absorbed from the plaster, the danger of decay is not so imminent.

323. Partition to scullery. A bricknogged partition is detailed at No. 123 for insertion between the sitting room and scullery of the cottage. A 4½″ × 3″ cill is laid on the damp-proof course of the foundation walling and 4″ × 3″ posts erected upon this at intervals of 2′ 6″ to 3′. The posts must be spaced (*a*) to suit the length of a number of bricks for subsequent filling, (*b*) to allow the formation of doorways, where these are required, and (*c*) to secure the position of any post for carrying a special load—as in the case of the trussed partition carried upon the head.—See detail No. 119.

The posts are tenoned to the cill, capped by a head of the same size and a door head is framed between the posts where required by bevel housed and pinned tenon joints as per detail No. 123 at A and B. In our case the doorway illustrated is the entrance to a store formed under the stair, and the door posts are placed close to the staircase walls, being bonded thereto at the quoins with 1″ × $\frac{1}{10}$″ hoop iron anchors, tarred and sanded. When the timber erection is complete, the spaces between the posts are filled with bricknogging. The courses should "fill," without excess of mortar at the joints, bond correctly, project a little in front of the wooden posts and be tied horizontally by bonding strips of straight-grained stuff 4″ wide by ⅜″ thick. Wrought iron bonding strips 2″ × $\frac{1}{16}$″ may be employed, or two bands of hoop iron bent up at the ends and clout nailed to the studs; again, steel wire netting prepared in 2½″ wide rolls may be embedded in the joint and turned up against the posts.

324. Wire mesh reinforcement. Having referred to wire net reinforcement it should be noted that this is an excellent way of tying and reinforcing a half-brick wall without the introduction of any woodwork, because the "net" may be continued into the main



wall at each end; and if used every four or five courses a strong wall is obtained. See Vol. II.

325. Floor over bricknogged partition. Floor joists are carried directly by this partition upon the head. They are bricked between and a "plain" stud partition is erected upon the joists similar to the example of detail No. 117, between bathroom and landing.

CHAPTER ELEVEN

JOINERY

Doors, Frames and Finishings

326. Joinery, as previously described, differs from carpentry in that it is applied only to fittings and finishings.—See page 102.

Wooden doors are generally pivoted to "frames" of similar material, which are provided as a margin to the door opening. Frames are constructed to suit the opening, and the doors to fit the frames. We shall study the forms of door frame in common use and the methods of securing them in position.

327. Frames. An external "door frame" is a rim of strong material placed along the sides and top of a door opening, from $3\frac{1}{2}'' \times 3''$ to $5'' \times 4''$ in cross section, firmly fixed to the jambs, and varying in size according to the weight and dimensions of the door to be attached to it.

The jambs may be either "plain" or "recessed," the latter being preferable and generally adopted, unless the opening is sheltered from high winds and driving rain.

Frames may be placed in position in two ways:

(*a*) Built in as the walling proceeds and secured to wood slips walled into the joints, or fixed by building in iron holdfasts screwed to the frame.

(*b*) Placed in position after the shell of the building is completed, and secured by wedging and spiking to wood plugs driven into the horizontal joints of the jambs.

Recesses in jambs intended to receive door frames are usually from 2" to 3" deep in stone work, and $2\frac{1}{4}''$ in brickwork, and the frame is expected to overlap the reveal $1\frac{1}{4}''$ *at least* into the recess.

328. Built-in frames. When the frame is built-in, the brickwork around it is usually butted closely against the back edge and although this has the effect of excluding much draught when the outside joint is well made—and possibly pointed in mastic—it is objectionable because the contact of wet mortar and exposure to the weather during building operations often induce rot, especially if the least margin of sap is left in the wrought frame. Building-in is very common in brick districts in the erection of cheap property, its object being to save labour in building by placing the frames truly vertical and using these as a guide for rapid bricklaying. "Plumb testing" is then largely neglected or negligently carried out.

329. Correct method of fixing frames. The better method is to complete building operations first, and subsequently, when ready for fixing the frames, prepare the jambs by plugging the horizontal joints at 2′ 6″ vertical intervals, cut the plugs off to allow the frame to pass neatly into position, while showing the correct margin within the reveals; then bed the frame on a layer of oil putty, force the woodwork tightly against it, and spike neatly in place with the spikes inclined a little towards the notch of the jamb. Superfluous putty is trimmed off accurately to the reveal and compressed by smoothing with the trimming knife.

In order to ensure "adhesion of the putty" to the door frame and brickwork, in the best work the surfaces are coated with boiled linseed oil, which is left to oxidise until "tacky," when the frame is bedded and secured. Two coats of oil may be necessary and, where desired, "oil paint" may be substituted for the clear oil.

330. Securing frame to threshold. When door frames are built-in, it is wise to dowel the feet of the posts (uprights) into the threshold with ½″ round or square "iron dowels," 3″ to 4″ long. Then any shock to the frame on closing a door violently is better provided against.

Frames to heavy doors are similarly treated, regardless of the method of fixing the frame to the jamb.

331. Nailing to wood slips. Frames of all kinds are fixed by building timber into the brickwork at requisite positions along the jamb. Pieces of "brick size" *replacing* a brick should not be used; a more satisfactory way is to insert a ⅜″ to ½″ slip or "pallet," slightly thicker than the average mortar joint, to ensure a grip and prevent it becoming loose after shrinkage. "Breeze" bricks, which accept and retain driven nails, are also employed. The firmest fixing can always be obtained by judicious "pluggion," unless nut and bolt attachments be adopted.

332. Choice of section of frames. The choice of section of a door frame depends upon its position, size of door, direction in which it opens (within the building or outwards) and the amount of decoration desired in the detail. Suitability of frames for definite circumstances will be gathered from the examples which follow.

333. Jointing of frames. All frames require jointing at the angles between the "posts" (uprights) and "head" (top piece). The form of joint varies with the shape of frame adopted and with local practice and circumstances, but is generally an application of the mortice and tenon joint in which a projection on one piece (tenon) enters a slot, closed at the sides but not necessarily at its ends (mortice). The most satisfactory joints have "wedged" tenons. Details Nos. 124 and 125 show these methods of jointing.

334. Door frames to cottage. E.C. doorway. Detail No. 126 shows a frame prepared for building-in, fitted between plain walls—acting as jambs—dowelled at the base of the posts to the brick threshold, and having its "rebate" for the door formed by nailing a 2″ × ½″ "stop" on the inside face of the posts. The door opens "outwards," hence the rebate is on the external edge.

Observe the section of the frame and method of jointing posts and head as shown at A, detail No. 124, by a wedged mortice and tenon joint.

335. Tool shed doorway. Detail No. 127 illustrates a plain frame for the tool shed door—showing the latter attached—prepared for outward opening with "rebated posts" and a "plain head"; the latter is due to the door being left short at the top for ventilation. The frame is jointed at the top angles with an open mortice and tenon joint secured by a ½″ oak pin. This joint is suitable for, and employed most in, "hand worked" frames.—See detail No. 124 B. The "head" may be 4″ × 3″ or 4″ × 4″ and the latter size almost fills the 3″ notch at the "head reveal," which is an advantage for this type of finish.

Probably the best method of preparing and fixing such a frame is to tenon the posts to the head, leave the latter longer than required in order to allow wedging at the edges of the tenon and to assemble the joints in "red lead and oil" paint.

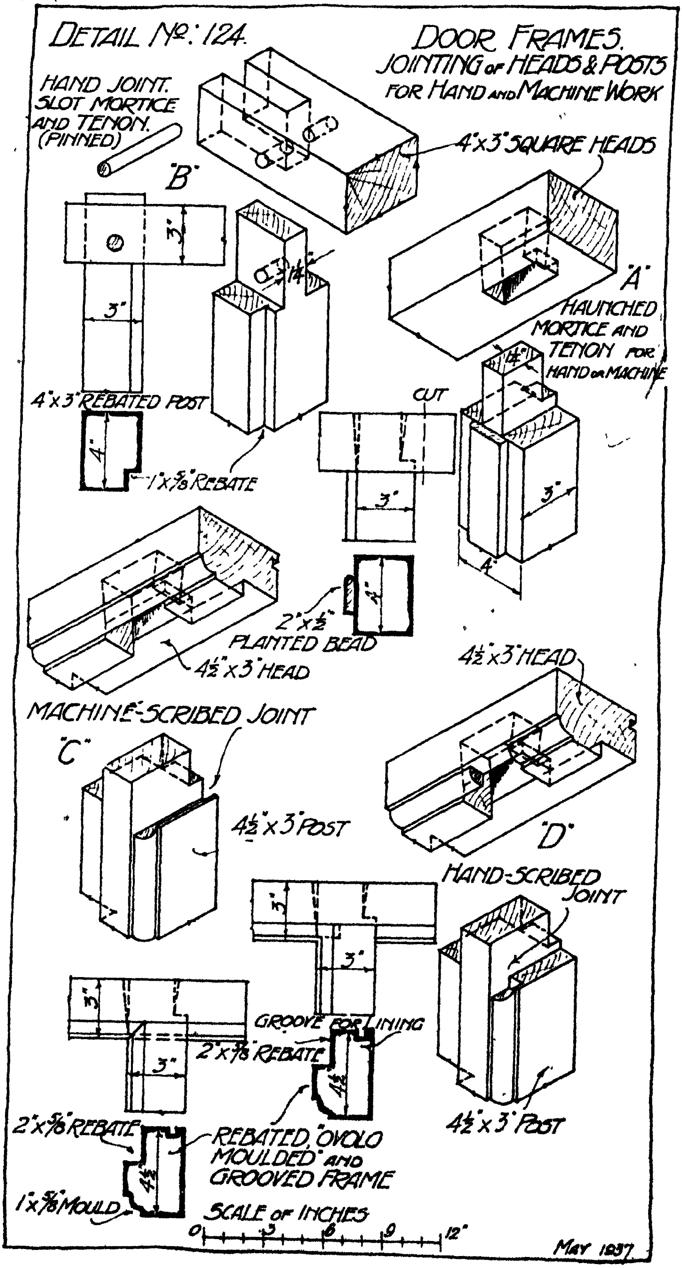
If required to be "built-in," the ends are left 4½″ longer than the back opening; *otherwise*, the tenons are "haunched" (cut narrower) from the back, then, after wedging, the superfluous length of the head is removed, retaining only the length to "fill the opening."

336. Entrance door frames. The frames previously considered are intended for comparatively unimportant doors.

Frames for entrance doors to dwellings—back or front—are practically always rebated within, for doors opening inwards. The outer angle of the margin showing round a doorway is then chamfered or moulded, which causes a scribed intersection to be necessary as shown in sketch at detail No. 124 C. The frame should not generally be less than 4½″ × 3″, for which the modern form of machine-scribed joint is shown, having a 1¼″ tenon on the square edge of the frame, haunched and wedged.

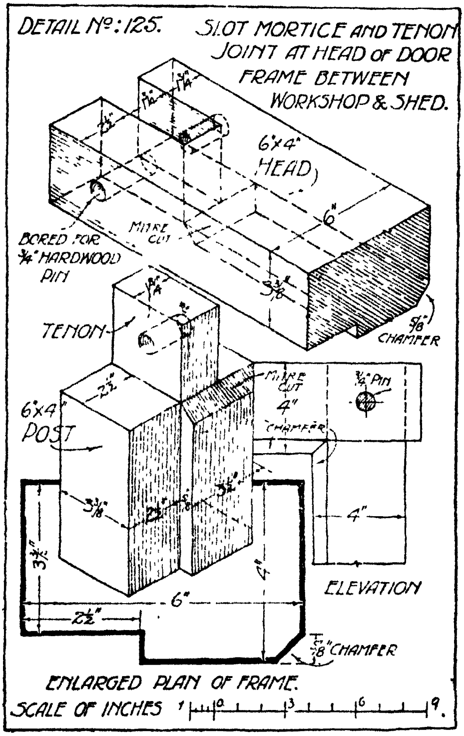
337. Use of double tenons. Double tenons are suitable for frames over 4½″ wide, as they enable the joints at the shoulders to be kept close, because the fixing of the wedges acts near the face of the stuff. In some districts double tenons are not used, but single ones placed within the "stop" of the frame as at C.

338. Door frames to workshop. Examination of details Nos. 125, 128 and 130 will show that some slight variations in size and moulding


DETAIL No: 124.
DOOR FRAMES.
JOINTING OF HEADS & POSTS
FOR HAND AND MACHINE WORK
HAND JOINT.
SLOT MORTICE
AND TENON.
(PINNED)
"B"
4"x3" SQUARE HEADS
"A"
HAUNCHED
MORTICE AND
TENON FOR
HAND OR MACHINE
4"x3" REBATED POST
1"x5/8" REBATE
CUT
2"x1/2"
PLANTED BEAD
4½"x3" HEAD
MACHINE-SCRIBED JOINT
"C"
4½"x3" POST
"D"
HAND-SCRIBED
JOINT
GROOVE FOR LINING
2"x5/8" REBATE
REBATED, "OVOLO
MOULDED" AND
GROOVED FRAME
1"x5/8" MOULD
SCALE OF INCHES
0 3 6 9 12"
MAY 1937

occur, but the construction is similar to that employed for the "entrance door" frames to cottage. We shall refer to these when considering the remaining details of the doors and finishings.

339. Size of external door openings. External door openings must be of sufficient size to meet the requirements of intended use, and it should be borne in mind that a frame, even if fixed in recessed jambs, reduces the opening by 2″ to 3″ for effective use.



Outhouses, W.C.'s, E.C.'s, etc. may have doors 2′ 6″ wide, which, allowing for ½″ rebates, means a nett opening 2′ 5″ wide, but the main entrance to a dwelling should provide at least 3 ft. clear width and back doors 2′ 9″ clear. We regard these as minimum widths for the entry of average sized furniture and the sizes chosen for the front and back doors of the cottage are larger Workshop and other doorways must be of adequate size for passing bulky articles such as the nature of the manufacture demands The maximum width of opening for a single door is advisedly 3′ 9″.

The height of a doorway is equally important; 6′ 6″ is generally accepted as the absolute minimum for the door, but the width and height need to be considered from the point of view of proportion and it will be found a dependable rule, to *make the height 4 ft. greater than the width* until 7′ 3″ is reached.

Beyond this the division of the panelling must be treated to give the desired appearance of proportion.

Special considerations may cause the proportioning rule to be inapplicable, an example of which occurs in the front door to cottage. Panel treatment overcomes the difficulty in this case.

The size of a doorway is dependent on the size and proportion of door and in brickwork the nearest brick dimensions to the desired ones are adopted.

EXTERNAL DOORS

340. External doors are of three general types, with numerous variations in the detail of each type.

First. Doors composed of vertical boards or "battens," kept together by horizontal "bars" or "ledges."

Second. Doors having a well constructed outer framing, suitable for containing vertical boards "within" the frame, and secured to it.

Third. Doors having a framing of uniform thickness, divided into rectangular spaces and filled with "panels," usually of thinner material, inserted in grooves worked upon the edges of the framing.

Note.—The main members of a "door" are referred to as the door "framing." The rim (previously described) to which the door is pivoted is called a door "frame." These terms are liable to confuse a student; in some parts of the country the door frame is called a "casing" which clearly distinguishes the two.

We shall now consider the three classes of door in detail.

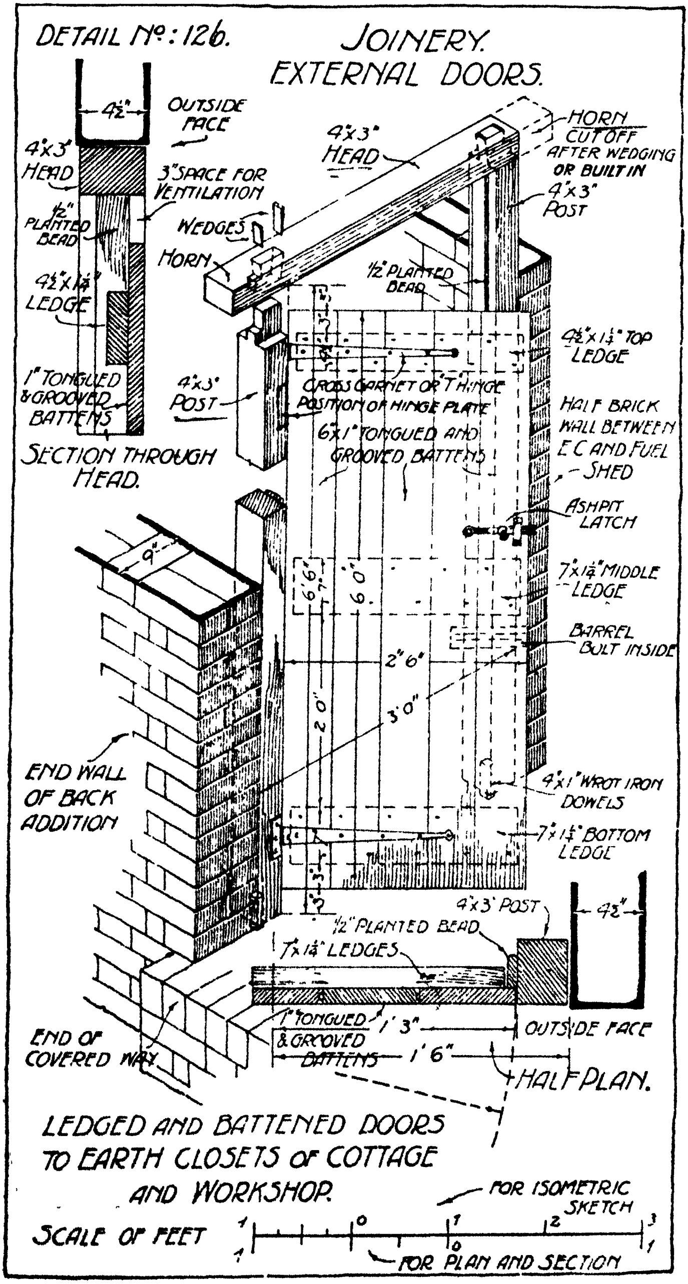
TYPE I. Doors consisting primarily of battens and ledges

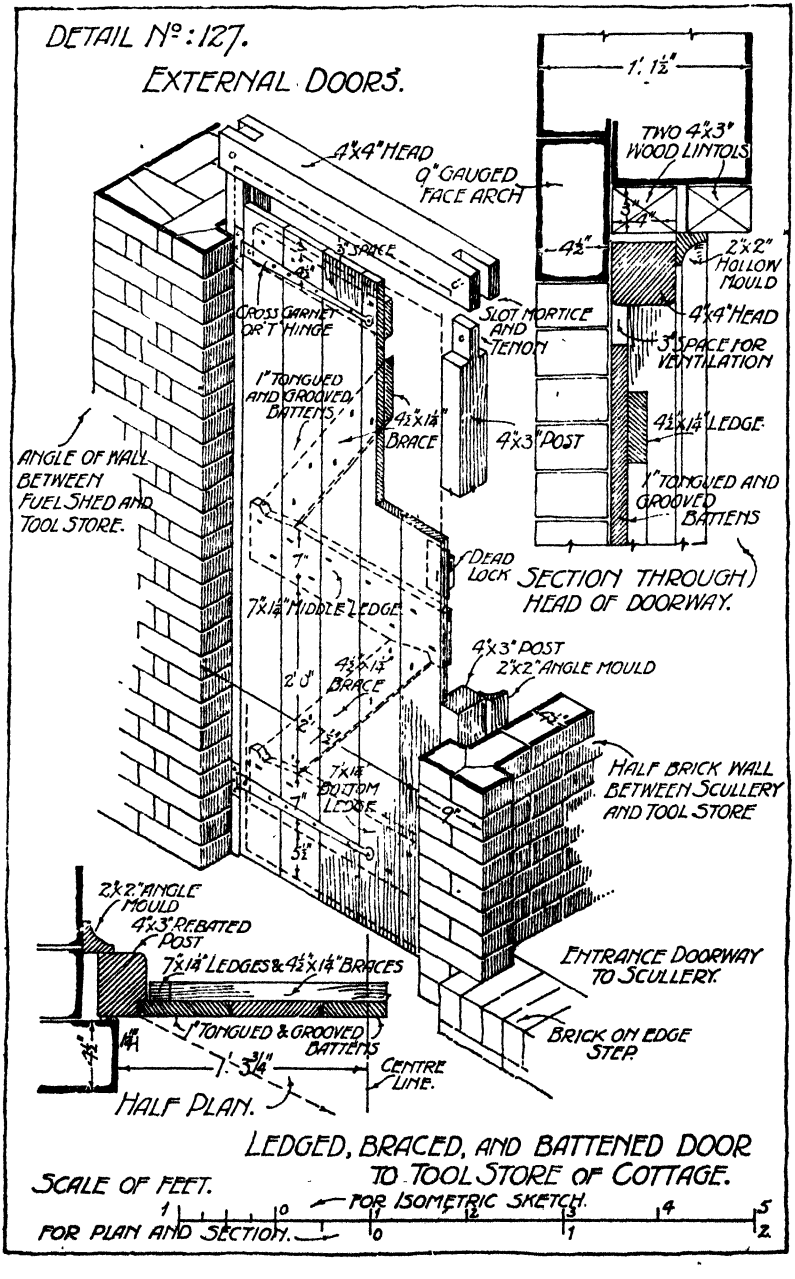
341. (*a*) Detail No. 126 shows the simplest form of this class, called a "*ledged and battened*" door. It is cheap, quickly made, and may serve fairly well under favourable conditions. The "battens" are tongued and grooved at the edges, 6″ nett width, five pieces forming a door 2′ 6″ in width. Ledges—which should not be spaced beyond 3 ft. centres—are three in number, the two lower 7″ × 1¼″ and the upper 4½″ × 1¼″. Top and bottom ledges are placed 3″ to 4″ from the ends, all are prepared "out of winding" and secured by two nails to each board placed diagonally and 1″ clear of the edges of batten and ledge.

Two defects are very noticeable in these doors: first, a tendency to "twist," and second, liability to droop at the opening edge as the battens shrink in width and the nails "give" under the weight. Straight grained timber truly prepared will prevent twisting, and the tendency to droop may be minimised by placing the nails in each batten and ledge as far apart diagonally as possible. Wide ledges assist this, but, unless framed, should not be greater than 7″, or their own liability to warp is excessive.

Ledges are secured by "clench nailing," wrought iron nails being used about ⅜″ longer than the total thickness of the timbers and "clenched" by turning the points back into the material.

The "thickness" of this class of door is described by the thickness of the battens which are suitably 1″ or 1¼″ nominal thickness, *i.e.* obtained out of 1″ or 1¼″ material.


DETAIL No: 126.
JOINERY.
EXTERNAL DOORS.
4½"
OUTSIDE FACE
4"x3" HEAD
3" SPACE FOR VENTILATION
½" PLANTED BEAD
4½"x1¼" LEDGE
1" TONGUED & GROOVED BATTENS
SECTION THROUGH HEAD.
4"x3" HEAD
WEDGES
HORN
HORN CUT OFF AFTER WEDGING OR BUILT IN
4"x3" POST
½" PLANTED BEAD
4½"x1¼" TOP LEDGE
4"x3" POST
CROSS GARNET OR T HINGE
POSITION OF HINGE PLATE
6"x1" TONGUED AND GROOVED BATTENS
HALF BRICK WALL BETWEEN E C AND FUEL SHED
ASHPIT LATCH
7"x1¼" MIDDLE LEDGE
BARREL BOLT INSIDE
2'6"
3'0"
6'6"
6'0"
2'0"
END WALL OF BACK ADDITION
4"x1" WROT IRON DOWELS
7"x1¼" BOTTOM LEDGE
4"x3" POST
½" PLANTED BEAD
7"x1¼" LEDGES
4½"
1" TONGUED & GROOVED BATTENS
1' 3"
1' 6"
OUTSIDE FACE
HALF PLAN.
END OF COVERED WAY
LEDGED AND BATTENED DOORS TO EARTH CLOSETS OF COTTAGE AND WORKSHOP.
FOR ISOMETRIC SKETCH
SCALE OF FEET
FOR PLAN AND SECTION


DETAIL Nº: 127.
EXTERNAL DOORS.
4"x4" HEAD
9" GAUGED FACE ARCH
1' 1½"
TWO 4"x3" WOOD LINTOLS
3"
4"
4½"
2"x2" HOLLOW MOULD
4"x4" HEAD
3" SPACE FOR VENTILATION
4½"x1¼" LEDGE
1" TONGUED AND GROOVED BATTENS
SECTION THROUGH HEAD OF DOORWAY.
3" SPACE
CROSS GARNET OR 'T' HINGE
SLOT MORTICE AND TENON
1" TONGUED AND GROOVED BATTENS
4½"x1¼" BRACE
4"x3" POST
ANGLE OF WALL BETWEEN FUEL SHED AND TOOL STORE.
DEAD LOCK
7"x1¼" MIDDLE LEDGE
4"x3" POST
2"x2" ANGLE MOULD
4½"x1¼" BRACE
2' 0"
2' 7½"
7"x1¼" BOTTOM LEDGE
7"
5½"
9"
HALF BRICK WALL BETWEEN SCULLERY AND TOOL STORE
2"x2" ANGLE MOULD
4"x3" REBATED POST
7"x1¼" LEDGES & 4½"x1¼" BRACES
1" TONGUED & GROOVED BATTENS
ENTRANCE DOORWAY TO SCULLERY.
BRICK ON EDGE STEP.
1¼"
4½"
1'-3¼"
CENTRE LINE.
HALF PLAN.
LEDGED, BRACED, AND BATTENED DOOR TO TOOL STORE OF COTTAGE.
SCALE OF FEET.
FOR ISOMETRIC SKETCH.
FOR PLAN AND SECTION.

342. (*b*) **Ledged, battened and braced door.** This form of door aims at remedying the defect of drooping, by adding diagonal members called braces, which are inclined downwards from the opening edge to the pivoted one, as in detail No. 127. The braces —really struts—should be 4½″ to 6″ wide, and are housed obliquely into the ledges 2″ clear of the ends, abutting with a square shoulder 1″ deep to ensure a direct thrust. If the ledges are of well seasoned material so that the brace joints do not become loose by shrinkage, the form of the door is much better maintained; clench nailing of the braces to every batten also helps to make it rigid.

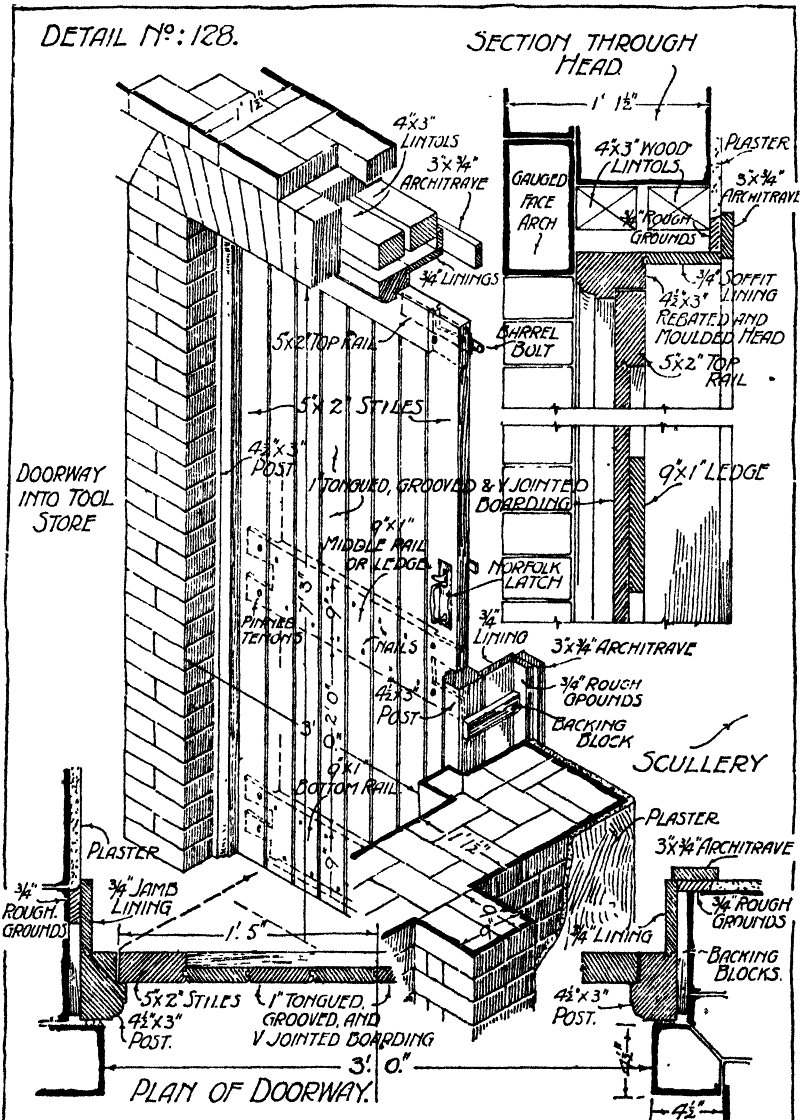
TYPE II. **Doors formed of framing filled in with vertical boards**

343. (*a*) **Framed, ledged and battened door.** Both the above doors are faulty in appearance and efficiency. For the entrance doors to a dwelling a more rigid door is required, viz. one that will better resist change of form. It should also preserve a true face and fit accurately into the rebates of the frame; twisted doors are the frequent cause of draughts.

The first step towards an improvement is to add a well framed rim to the battens having broad "cross rails" (or ledges) behind the latter. In detail No. 128 an example is given applied to the "scullery entrance" of the cottage; the framing consists of two "stiles" and a "top rail," 5″ × 2″, with two ledges, 9″ × 1″, mortised and tenoned together as illustrated in isometric detail No. 129. The joint between "top rail to stile" has a tenon one-third the thickness (⅝″ approx.) placed centrally and "haunched" 2″ from the top. The connections between "stile and ledges" are known as "barefaced tenon" joints, the tenon being necessarily flush on one face of the ledge because of its reduced thickness. It is also divided into two tenons each 2¾″ wide with a space of 3½″ between them, which avoids cutting a long, weakening slot in the stile; a tenon full width would "buckle" when wedged tight, causing the stile to split.

Observe that the thicknesses of the members of this frame allow them to be assembled "flush on the back," leaving a recessed area in front which must be slightly deeper than the battened filling. To provide support for the top ends and outer edges of the battens the "rim" is grooved to suit tongues formed thereon. Battens are fitted in position to fill exactly the width in uniform pieces, and clench nailed to ledges and rails like a ledged door.

In all doors consisting of three cross rails they are most commonly distinguished by the names "bottom rail," "middle (or lock) rail," and "top rail."

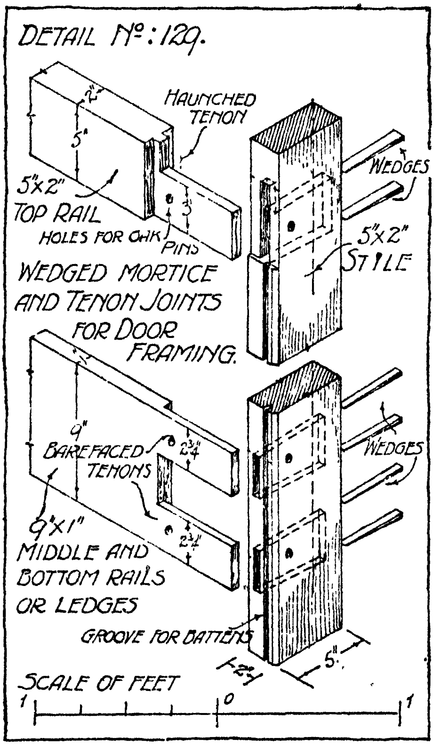


FRAMED, LEDGED, AND BATTENED DOOR TO SCULLERY OF COTTAGE.

SCALE OF FEET. FOR ISOMETRIC SKETCH 1 0 1 2 3 4 5
FOR PLAN AND SECTION. 0 1 2

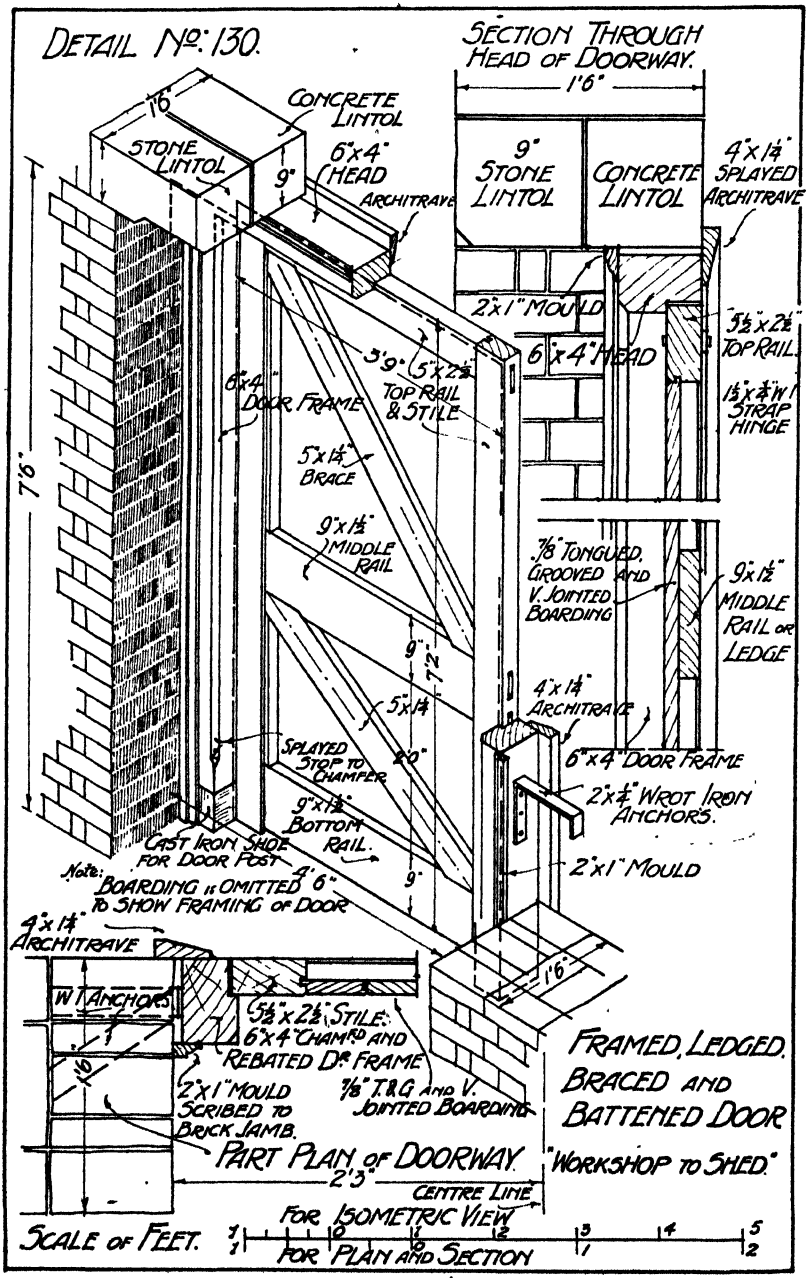
The efficiency of this door depends upon (*a*) the fit and correct wedging of the tenons, (*b*) breadth of the rails (or ledges).

Wedges must fit the "bevel of the mortices" and be slightly tighter at the *point* when driven, rather than at the *head* of the wedge. This ensures the shoulder keeping "close" by holding the tenon tight near the joint; $\frac{3}{8}''$ diameter "hard-wood pins" should be added as a safeguard, one to each tenon placed through the stile within $\frac{3}{4}''$ of the shoulder.



Breadth of rails affects the rigidity by preventing "rotation of the joint" which is possible after the stiles and rails shrink. This is the sole constructive reason for using deep rails; the principle is often overdone by using 11″ rails, which are ugly and also liable to greater shrinkage.

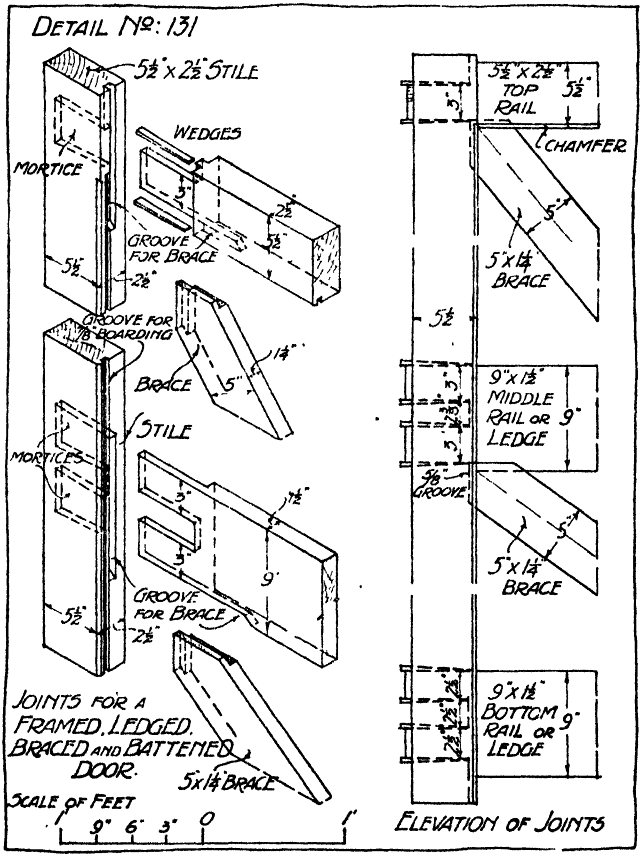
344. (*b*) **Framed, ledged, braced and battened door.** The addition of diagonal braces to this door takes some of the strain off the joints and makes for greater efficiency still, in "preventing droop" at the "free edge." Bracing is often done by cutting 4″ × 1″ pieces to fit diagonally within the rectangular recesses at the back of the door


DETAIL No: 130.
SECTION THROUGH HEAD OF DOORWAY.
1'6"
CONCRETE LINTOL
STONE LINTOL
9"
6"x4" HEAD
ARCHITRAVE
9" STONE LINTOL
CONCRETE LINTOL
4"x1¼" SPLAYED ARCHITRAVE
2"x1" MOULD
6"x4" HEAD
5½"x2½" TOP RAIL.
1½"x¾" W.I. STRAP HINGE
3'9"
5"x2½" TOP RAIL & STILE
6"x4" DOOR FRAME
5"x1¼" BRACE
9"x1½" MIDDLE RAIL
7/8" TONGUED, GROOVED AND V. JOINTED BOARDING
9"x1½" MIDDLE RAIL OR LEDGE
7'6"
9"
7'2"
5"x1¼"
4"x1¼" ARCHITRAVE
6"x4" DOOR FRAME
SPLAYED STOP TO CHAMFER
2'0"
2"x¾" WROT IRON ANCHORS.
9"x1½" BOTTOM RAIL.
CAST IRON SHOE FOR DOOR POST
2"x1" MOULD
Note: BOARDING is OMITTED TO SHOW FRAMING OF DOOR
4'6"
9"
4"x1¼" ARCHITRAVE
W.I. ANCHORS
1'6"
5½"x2½" STILE.
6"x4" CHAMFD AND REBATED Dr FRAME
2"x1" MOULD SCRIBED TO BRICK JAMB.
7/8" T.&G. AND V. JOINTED BOARDING
FRAMED, LEDGED, BRACED AND BATTENED DOOR
"WORKSHOP TO SHED."
PART PLAN OF DOORWAY
2'3"
CENTRE LINE
SCALE OF FEET.
FOR ISOMETRIC VIEW
FOR PLAN AND SECTION
1 0 1 2 3 4 5
1 0 1 2
1 1

(inclined downwards towards the hinges) and nailing them to the battens without any attempt at jointing.

This serves for ordinary work, and in rectifying an omission.

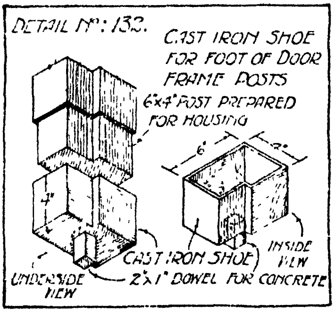
345. Workshop. Shed entrance. In detail No. 130, which illustrates the door to the shed entrance of the workshop, a better



method of construction is shown, suitable for large doors of this type. The braces are placed centrally across the diagonal of the rectangle and tenoned to the framing by ½" bare faced tenons on each abutting end. This necessitates a slight alteration in the position of the tenon on the adjoining rails (see A and B in detail No. 131), but the arrangement ensures the braces being secure and independent of nailing; they require insertion when the frame is being assembled and wedged up.

346. Joints in boards. In all battened doors the boards are "matched" at the edges, being tongued and grooved and "V jointed" or "beaded" to hide the effect of slight shrinkage in producing an open joint. V joints should not exceed $\frac{1}{8}''$ each way of the chamfer, and beads, if used here, about $\frac{1}{4}''$ diameter.

Note. While studying detail No. 130 observe the "door frame." It differs a little from previous examples. The jambs against which it fits are "plain" and the frame is set flush with the brickwork on the inside; plastering is not required. This frame is 6″ × 4″ rebated and chamfered, and the foot of the post is provided with a cast iron "foot" or "shoe," detail No. 132, having a 1″ square dowel pin cast upon it for insertion in the threshold; the shoe prevents the absorption of water in places where rain is driven upon the threshold, but its purpose here is to stiffen the frame and resist abrasion by heavy articles which may be dragged along the floor through the doorway.



Before insertion, the door post and C.I. socket should be well painted and allowed to dry, and *on* insertion, both repainted on the surfaces in contact.

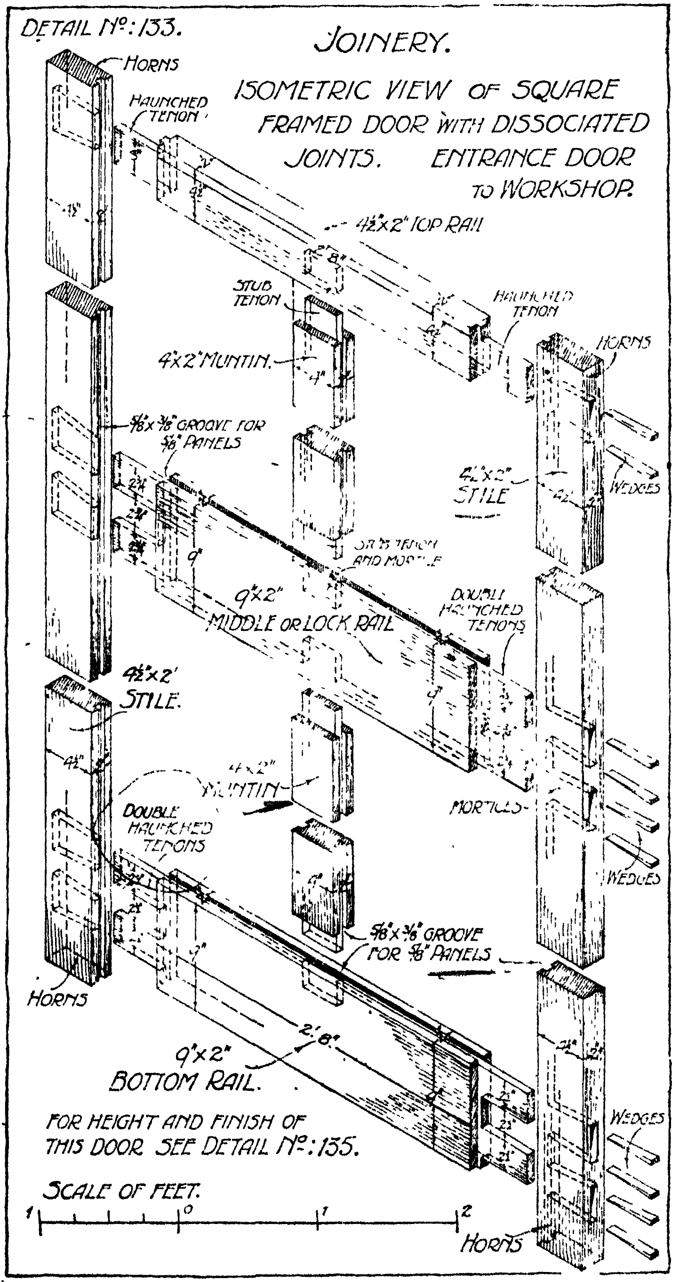
Such a frame needs to be rigidly fixed, and is intended to be built-in, having provision for anchoring the posts with 2″ × $\frac{1}{4}''$ bent anchor bars of W.I. screwed to the frame. One anchor is shown bent diagonally towards the "centre" of the wall, which is more effective.

TYPE III. Panelled Doors

347. Panelled doors, while varying much in detail, are all framed upon one principle, the members of the framing being uniform in thickness, with each inside edge grooved from $\frac{3}{8}''$ to $\frac{5}{8}''$ deep to receive a panel. The breadth of the groove depends on the type of panel adopted and its thickness relative to that of the framing.

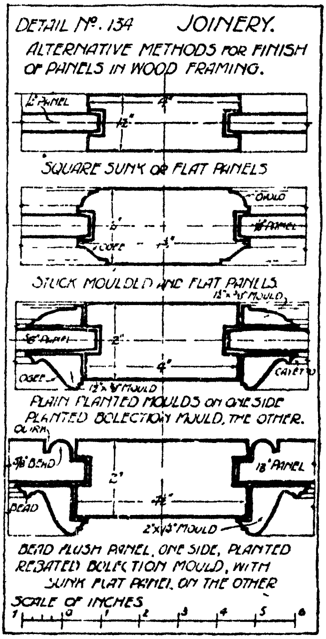
Detail No. 133 shows the "principle of framing" applied to a four-panelled door. The members constituting the framing are: "stiles" (outside verticals), "rails" (top, lock and bottom rails) connecting the stiles, and "muntins" (intermediate verticals) framed between the rails. All the joints are clearly shown in isometric detail and embody similar "stile and rail" joints to those employed in framed and ledged doors (except that they are centrally placed) and with short tenons, 2″ to 3″ long, at the "muntin and rail" joints.

348. Principle of framing. It is well to observe here that the "regular" procedure in designing and constructing framing of any kind (except windows) is to allow the face appearance to be as follows: "Allow the stiles to run through the full length, tenon the rails between these and place the muntins in short lengths between the rails." Exceptions occur, but these must be learnt later.


DETAIL Nº: 133.
JOINERY.
ISOMETRIC VIEW OF SQUARE FRAMED DOOR WITH DISSOCIATED JOINTS. ENTRANCE DOOR TO WORKSHOP.
HORNS
HAUNCHED TENON
4½"x2" TOP RAIL
STUB TENON
4"x2" MUNTIN.
HAUNCHED TENON
HORNS
5/8"x3/8" GROOVE FOR 5/8" PANELS
WEDGES
4½"x2" STILE
9"x2" MIDDLE OR LOCK RAIL
DOUBLE HAUNCHED TENONS
4½"x2' STILE.
4"x2" MUNTIN
DOUBLE HAUNCHED TENONS
MORTICES
WEDGES
5/8"x3/8" GROOVE FOR 5/8" PANELS
HORNS
2' 8"
9"x2" BOTTOM RAIL.
WEDGES
FOR HEIGHT AND FINISH OF THIS DOOR SEE DETAIL Nº: 135.
SCALE OF FEET.
1 0 1 2
HORNS

349. Naming of panelled doors. Panelled doors are named from the number of panels in the door, as "four-panelled," "five-panelled," etc.

350. Treatment of panels. The treatment of panels forms the chief variation in panelled doors. They may be plain (flat surfaces) with the edges of the framing left square, when they are known as "square and flat" panels; or the "edges of the framing" may be moulded, called *stuck moulded* and flat; or again the panels may have a margin of separately prepared moulding mitred or "planted" round the panel and nailed to the framing, and known as moulded and flat.—See detail No. 134.



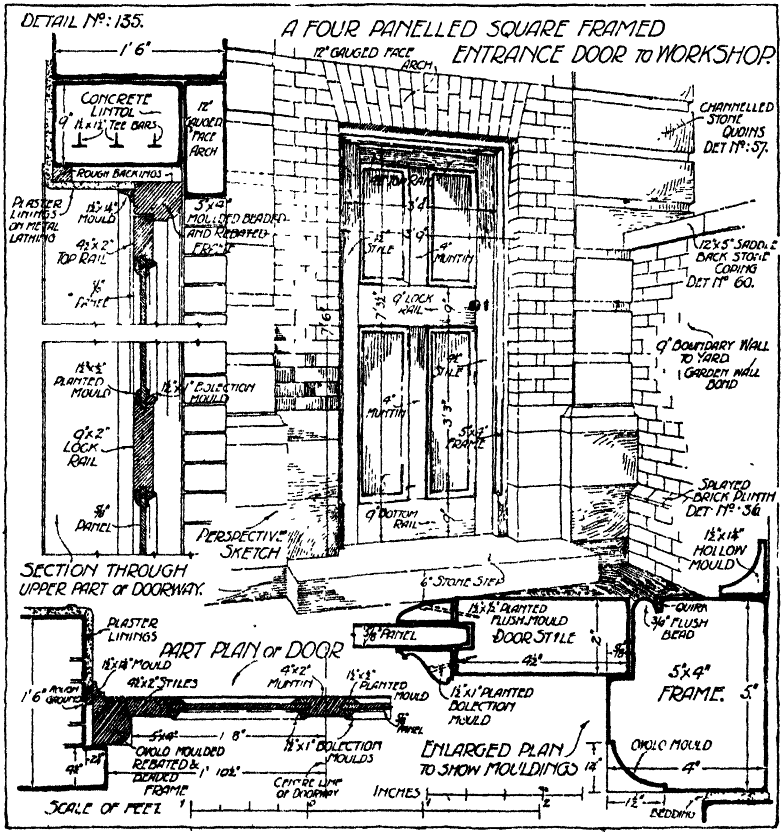
Considering the last type further, should the planted moulding *not* project from the face it is called a *flush mould*; if it *does* project it is named a *bolection* mould. Some bolection moulds are rebated on the outer edges to lap over the square edge of the framing about $\frac{1}{4}''$. The function of this lap is to hide the effects of shrinkage. All the above considerations have referred to flat panels. Should thicker panels be required they may be made flush on one or both faces and jointed to the framing by tongued edges as shown in the lower illustration of this detail.

351. Sizes of framing and panels. The minimum thickness of framing for external doors is $2''$ ($1\frac{7}{8}''$ finished) which is seldom departed from. Stiles and top rails are from $4'' \times 2''$ to $5\frac{1}{2}'' \times 2''$, lock and bottom rails $7'' \times 2''$ to $9'' \times 2''$ and muntins $4''$ or $4\frac{1}{2}'' \times 2''$. Panels if "flat" are from $\frac{1}{2}''$ to $\frac{7}{8}''$ thick, $\frac{5}{8}''$ finished being most common; if flush on one side they are usually from $1''$ to $1\frac{1}{8}''$. The breadth of a panel should not be excessive because of the "certain shrinkage," and where exigencies of design demand it $\frac{5}{8}''$ deep panel grooves are wisely supplied. Panels having a "total width" exceeding $11''$ will usually require to be "jointed."

352. Workshop. Main entrance door. The main or office entrance to the workshop is provided with a $2''$ four-panelled door having $4\frac{1}{2}'' \times 2''$ stiles and top rail, $9'' \times 2''$ lock and bottom rails and $4'' \times 2''$ muntins.

The panels are $\frac{5}{8}''$ thick, flat on both faces and surrounded by planted mouldings "flush" on the interior and "bolection" on the exterior.

Perspective detail No. 135 shows the doorway, door and frame, while the sectional forms of panels and mouldings are made clear in the same details. These details show how the mouldings are secured. Observe that planted moulds may not be nailed to the



panel or through it. Each mould must adhere to the edge of the framing *only*, moving with it, and should not interfere with the free movement of the panel as it expands and contracts during changes of temperature and moisture in the atmosphere[1].

The advantage of a panelled door of this type is the production of sufficiently rigid framing, with "light" filling, easy to make and keep "true," unhampered in movement due to changes of temperature and possessing great decorative possibilities.

[1] See Manson's *Building Science*, Vol. I.

Mouldings used for planting are wisely of small or medium size, and very small detail in the members or deep narrow sinkings being carefully avoided; these latter fill up and are destroyed by painting and the preconceived form of the designer is lost.

Disadvantages for external use. Panelled doors with planted mouldings, if used externally in unshielded positions, are liable to collect water behind the horizontal portions of the panel moulds, especially if the moulds warp and curl away at the inner edges. These conditions induce rapid decay of the material.

"Finishings" to External Doors

353. Having considered the form and construction of external doors and their frames we have now to study the method of finishing the woodwork around the opening, which on the interior is still improperly closed in. While we have made the opening weathertight by bedding the frame in putty and rebating the door to the frame, we have no finished connection between the plaster and woodwork, nor covering to the exposed brickwork at the jamb.

These are not always required, as will be gathered from the following description of the methods of finishing:

(*a*) Suppose no plaster to the walls and no need to produce a special finish, as in the tool shed. The frame may there be built-in, flushed in mortar and pointed off, or, if the frame be fixed subsequently, it may be neatly fitted to the jamb and securely plugged without any cover, as illustrated by detail No. 126.

(*b*) Where no plastering is required, but the frame does not fill the opening, a marginal mould or plain fascia may be cut to fit the brickwork closely (scribed) and mitred round posts and head of frame, leaving a parallel margin of wood frame exposed, as in detail No. 127.

(*c*) Return the plaster covering of the interior wall into the opening to finish against and close in the edges of the door frame. —See detail No. 135, which, in addition, has a small hollow angle mould, to close the joint and cover the rough ground.

(*d*) Fix margins or coverings of wood round the exposed jamb and cover their edges with architrave mouldings.

Method (*d*) is the most common arrangement for the internal finish of external doors to dwelling houses. Its function is to cover the exposed margin of brick jamb and also the edge of the plaster (or a rough ground against which the plaster finishes).

The horizontal and vertical sections of the scullery doorway, detail No. 128, will make this clear; marginal linings, $\frac{7}{8}''$ thick, termed "jamb and soffit linings," are tongued to the door frame and stand out at right angles to a distance of $\frac{7}{8}''$ in front of the brickwork, and a rough "ground" $2\frac{1}{2}'' \times \frac{3}{4}''$—with the outer edge splayed to hold the plaster—is fixed round the opening to plugs

in the jamb, at the correct position to receive the jamb lining, which is nailed to it, the two being flush with the required plaster surface.

354. Grounds. The function of the ground is to screed the wall plaster to a true face round the opening, allowing the plastering to be done before the jamb lining is fixed and also forming a groundwork for securing lining and architrave. Grounds are constructed of sawn material cut to an accurate size.

355. Architrave. An architrave is a marginal band enclosing an opening or recess, and in our application is a wooden moulding. It may be plain, chamfered or moulded in section and should overlap the plaster $\frac{1}{4}''$ to $\frac{3}{8}''$, completely covering the rough ground and also the joint between ground and lining. Its angles are mitred and nailed in both directions and the lower ends rest on the floor. Sizes of architraves vary from $2'' \times \frac{3}{4}''$ to $5'' \times 2''$. For types of architrave see various door and window details.

356. Backings to linings. In the isometric sketch, to the right of detail No. 128, will be seen a short horizontal bar of wood known as a backing block.

These are placed at vertical intervals of about 2′ to 2′ 6″, secured to wood slips or plugs and dovetailed to the edges of the rough grounds, in a similar manner to that shown in detail No. 138. Their function is to prepare a vertical surface on which the linings may be secured by nailing and also to form a guide to the plasterer in filling the recesses between the blocks, and thus prevent hollow spaces which allow of draughts and the collection of dust and vermin.

357. Fixing cheap joinery. In cheap cottages the rough grounds are omitted and also the backing blocks. The method adopted is to fix the door frame and linings to plugs driven into the horizontal joints of the jamb (allowing them to stand out if necessary and cut off neatly to the required projection for receiving the lining). The lining is allowed to project to the proposed plaster line and the wall surface plastered flush. Architraves are attached to the edge of the lining and to plugs alongside it at 3 ft. vertical intervals.

This method is objectionable because the dry linings are placed in a damp building, absorb moisture, expand seriously and weeks afterwards shrink considerably as the plaster becomes dry.

Opportunity to back them with plaster has been lost and in addition the plasterer invariably damages the woodwork with lime plaster and destroys its finish.

358. Frames flush with walls. Should a door frame be so placed as to be flush with the wall or plaster within, no jamb lining is required. Horizontal and vertical sections in detail No. 130, at door leading from workshop to shed, show one case with the architrave covering the joint and laid flat against the brick wall. At least half the width of the architrave must overlap the woodwork of the frame for security of nailing, or special plugs be placed in the jamb for fixing the outer edge.

INTERNAL "DOORS," "LININGS," AND "FINISHINGS"

359. The term "internal doors" includes all doors affording communication between the separate rooms of a building, or between the rooms and the various means of approach, as corridors, stair landings and lobbies. Doors to cupboards and storage fittings are not usually included.

An internal door is generally of the panelled type and may be of smaller size than the external doors to the entrances. Its minimum size is 6′ 6″ × 2′ 6″ though preferably larger. In the earlier parts of this chapter we have stated a rule for proportioning doors, viz. "that the height shall be made 4 ft. greater than the width." It will be seen that the minimum size conforms to it, as also do the following common sizes: 6′ 8″ × 2′ 8″, 6′ 9″ × 2′ 9″, 6′ 10″ × 2′ 10″ and 7′ × 3′.

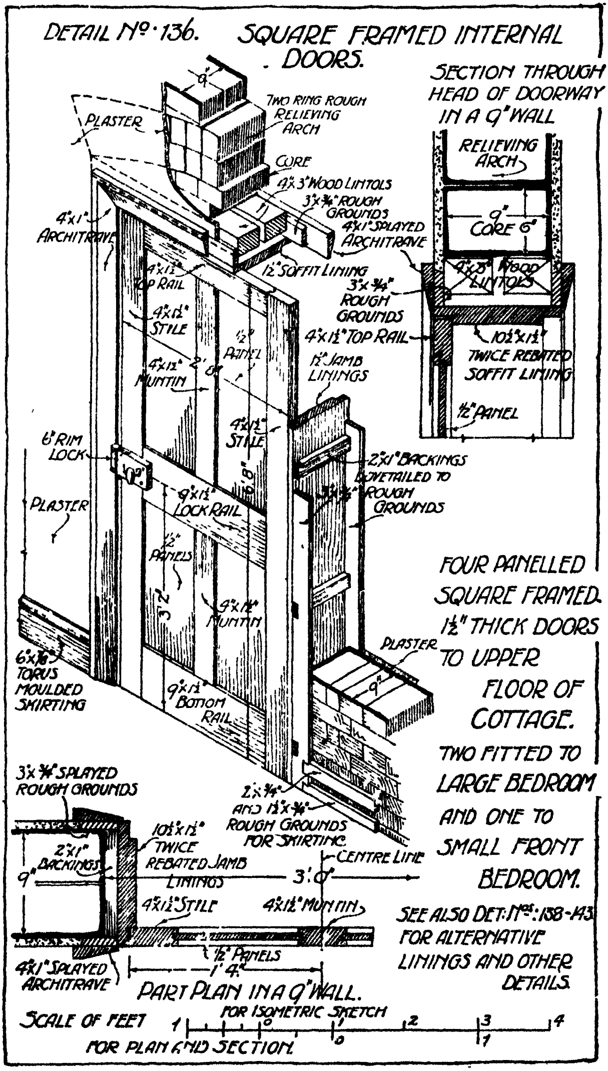
Choice of dimensions must lie with the designer, his decision being governed by the importance of the doorway or the difficulty of passing household goods through it when its immediate surroundings have been considered.

360. Four panelled door. The most popular form of internal door is the "four panelled," with the upper pair of panels longer than the lower pair, which we have adopted as being most suitable for the internal doors of the cottage.

Because these doors do not need to be so strong and heavy as external doors, their thickness is commonly 1½″ to 2″, with ½″ panels. Suitable dimensions of framing are: stiles, top rail and muntins 4″ wide, lock and bottom rails 9″ wide for doors up to 6′ 9″ × 2′ 9″, with 4½″ to 5″ stiles and top rail for doors up to 7′ × 3′. The mode of framing agrees exactly with that previously adopted for external doors.—See detail No. 133.

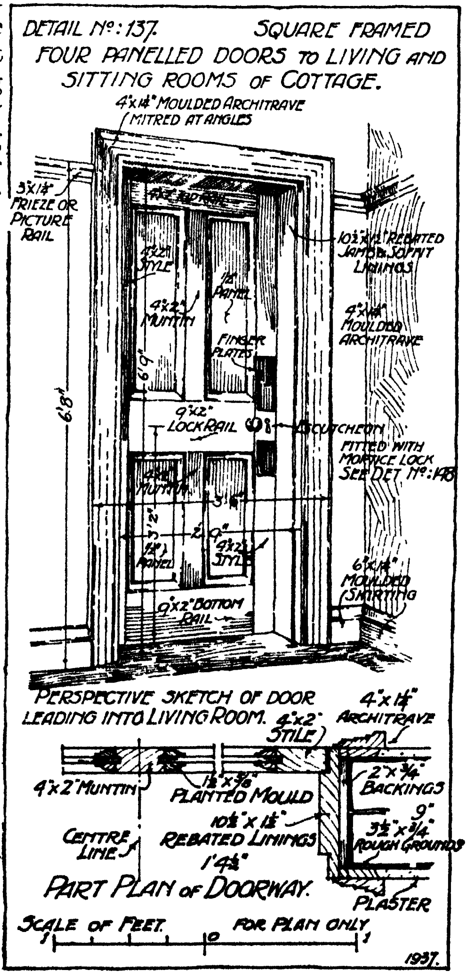
361. Height of lock rail. The height of the lock rail varies with personal choice; we prefer a height of 3′ to 3′ 2″ to the centre of the door handle, which is placed in the centre of the lock rail. In some districts, and also in manufactured doors of stock pattern, the lock rail is placed 3′ 0″ from floor to top edge, while in other cases 3′ 2″ to 3′ 3″ is chosen.

Obviously the height of door and width of rail selected makes a difference to the position; it must be satisfactory in the design of the door and in its usefulness of position.



362. Panels. Panels may be left plain, with square edged framing as in detail No. 136, suitable for unimportant positions, as, for example, store room under stair, and all doors to upper floor in the

cottage. When planted moulds are omitted, the panel grooves must be at least ½" deep, with the panel entering ⅜" full, because in materials of slightly defective seasoning, shrinkage would materially affect the "entry at the groove," reducing the cover and also the rigidity of the panel. On the other hand panels must not fill the grooves as the doors must often be placed in a building more or less damp, when they expand and the enlarging panels disturb the joints or buckle if made to fill the groove.



363. Moulded doors. Flush planted mouldings are in general use for 1½" doors, but if planted on both sides are either excessively thin, restricted in design or otherwise unsatisfactory, hence we prefer to use the 2" door for these cases. Observe that doors to corridors, stores, etc., where one side is ordinarily exposed in an important position, would be moulded on one side.

Details Nos. 136 and 137 should be studied most carefully, and proportions, joints and mouldings should be noted.

364. Relation of doors and frames. It will be observed that we have referred to the "doors" before the "frames" in this section, because it is usual to decide the size of an internal door first and to prepare the rebated frame to fit it.

365. Grounds, jamb linings and finishings. Jamb linings—called inner door casings in the North of England—are the pieces of material covering the square jambs of an internal opening and in

this sense serve the same purpose as the jamb linings to external doorways. It will be remembered that the latter were *thin* pieces to hide the brickwork of the jamb, but in internal openings the jamb lining usually serves to support the door upon its hinges, and must be strong enough for this purpose.

366. Economical methods. In ordinary houses linings are of $1\frac{1}{4}''$ material fixed to plugs in the jamb and whose width equals the thickness of wall plus twice the thickness of plaster.

The plaster, from $\frac{1}{2}''$ to $\frac{3}{4}''$ thick, is finished flush with the lining.

To receive the door and provide cover, a rebate $\frac{1}{2}''$ deep $\times$ (thickness of door + $\frac{1}{16}''$) is prepared and the door fitted with $\frac{1}{16}''$ clearance all round. An architrave nailed to the edge of the lining, and to the plugs used to secure the lining, covers the plaster joint and completes the finishings.

This method is unsatisfactory for work of any importance, and the following paragraphs describe the method adopted in good work.

367. Grounded work. The opening is prepared with rough (unwrought) grounds as shown in detail No. 136, to receive a $10\frac{1}{2}'' \times 1\frac{1}{2}''$ *twice rebated* jamb and soffit lining, all accurately set out and fixed to size. The grounds are $3'' \times \frac{3}{4}''$ neatly sawn stuff, one edge bevelled for plaster, overlapping the brick jamb into the opening about 1″. The grounds are nailed to plugs or wood slips within the horizontal joints at 2′ centres.

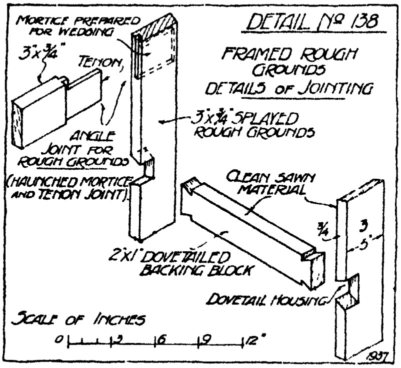
368. Framing of grounds. To prevent the "face grounds" from curling outwards $2'' \times 1''$ cross grounds or backing pieces are dovetail notched flush into their edges, as in detail No. 138. This is necessary, because the grounds when brought into contact with wet plaster absorb moisture, expand and warp; the cross ground opposes this tendency and provides a "backing" for securing the linings.

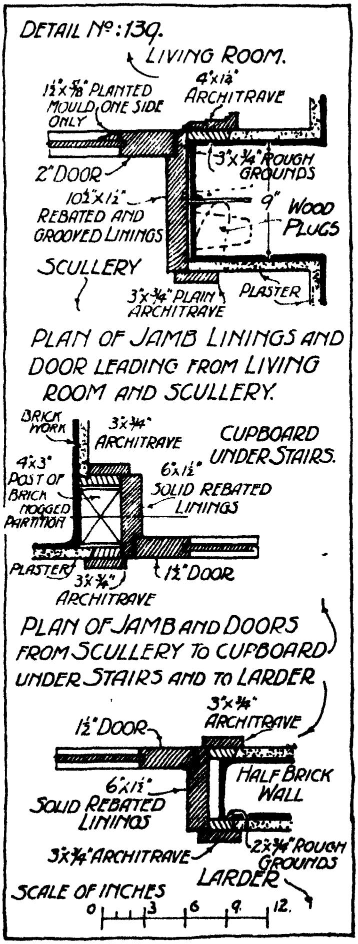
In good work face grounds are made rigid at the angles by a glued and wedged "haunch mortice and tenon" joint.

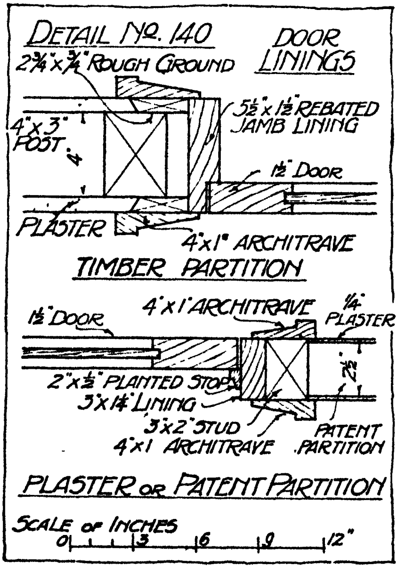
Detail No. 136 shows that rough grounds are also provided for the skirting along the floor level. These are dovetailed to the stile of the face grounds to the doorway.

369. Linings to thin walls and partitions. Details Nos. 139 and 140 show sections through partitions on the ground floor and upper floor, and show how the linings are treated. The vertical grounds are nailed to the $4'' \times 3''$ door post or plugged to the brick jamb; the

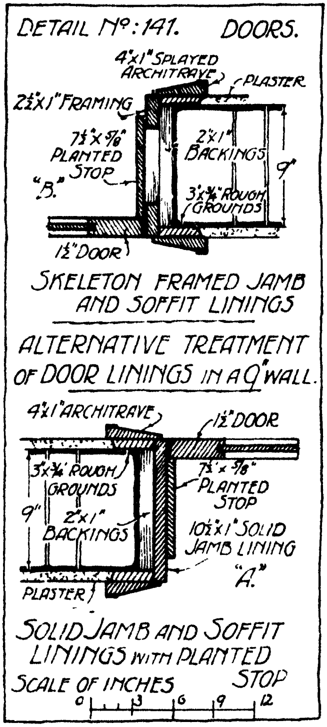
lining is only "single rebated." Cross grounds are not required. If the same width of architrave is used on both faces, the grounds vary in width to provide equal margins and to restrict the lap over the plaster to $\frac{1}{4}''$ or $\frac{3}{8}''$.

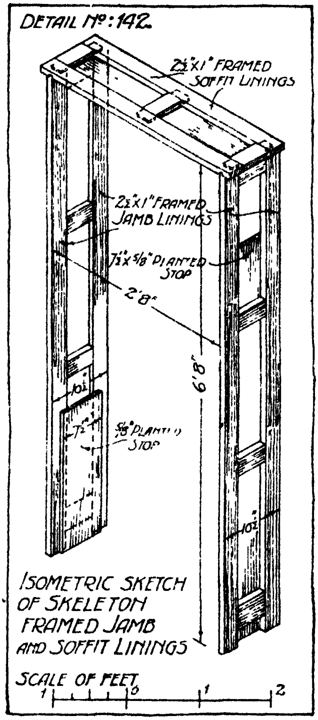


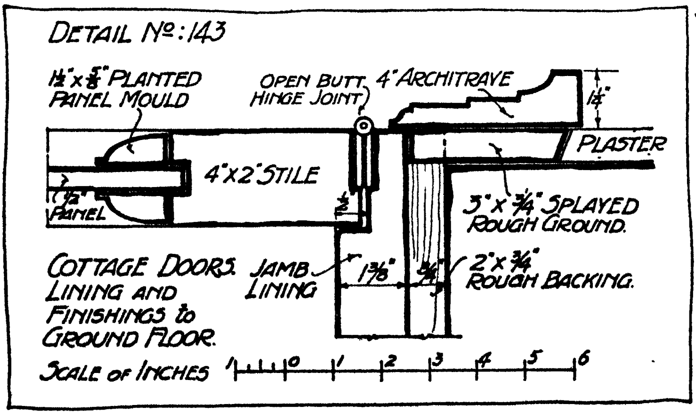




370. Double and single rebated linings. In some districts "double rebated" jamb linings are practically unknown. The idea probably originated through the alternative method of forming the "stop" of a door by nailing a $\frac{1}{2}''$ piece on the face of the jamb lining as shown


DETAIL Nº: 141. DOORS.
4"x1" SPLAYED ARCHITRAVE
PLASTER
2½"x1" FRAMING
7½"x⅝" PLANTED STOP
"B."
2"x1" BACKINGS
3"x¾" ROUGH GROUNDS
9"
1½" DOOR
SKELETON FRAMED JAMB AND SOFFIT LININGS
ALTERNATIVE TREATMENT OF DOOR LININGS IN A 9" WALL.
4"x1" ARCHITRAVE
1½" DOOR
3"x¾" ROUGH GROUNDS
7½"x⅝" PLANTED STOP
9"
2"x1" BACKINGS
10½"x1" SOLID JAMB LINING
"A."
PLASTER
SOLID JAMB AND SOFFIT LININGS WITH PLANTED STOP
SCALE OF INCHES
0 3 6 9 12


DETAIL Nº: 142.
2½"x1" FRAMED SOFFIT LININGS
2½"x1" FRAMED JAMB LININGS
7½"x⅝" PLANTED STOP
2'8"
6'8"
10½
⅝" PLANTED STOP
ISOMETRIC SKETCH OF SKELETON FRAMED JAMB AND SOFFIT LININGS
SCALE OF FEET
1 0 1 2

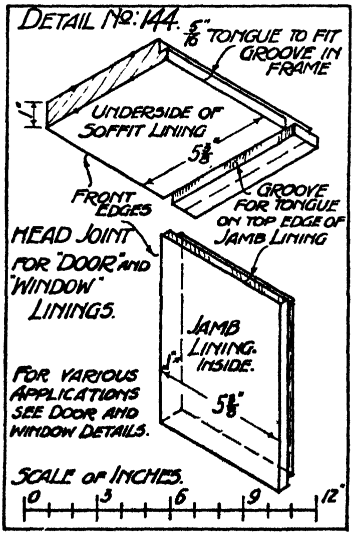

DETAIL Nº: 143
1½"x⅝" PLANTED PANEL MOULD
OPEN BUTT HINGE JOINT
4" ARCHITRAVE
1¼"
PLASTER
4"x2" STILE
½" PANEL
3"x¾" SPLAYED ROUGH GROUND.
COTTAGE DOORS. LINING AND FINISHINGS to GROUND FLOOR.
JAMB LINING
1⅜"
¾"
2"x¾" ROUGH BACKING.
SCALE OF INCHES
1 0 1 2 3 4 5 6

in detail No. 141 at A, in which case as narrow a piece as convenient would be used, consistent with appearance. But double rebating improves the appearance and overcomes irregularities of arrangement in the grounds, marginal exposure of edges of lining, etc., such as were suggested in the last clause; they also allow of the reversal of a door if necessary, or the addition of a second door for sound proofing, though such changes could scarcely be of importance in the original detailing.

371. Framed linings to jambs and soffit. Another excellent method is available for grounding the jambs and soffit of an internal doorway, particularly suited to openings in 9″ or thicker walls.

The jamb linings are framed together with mortice and tenon joints in three skeleton frames.—See isometric detail No. 142. The material employed is $2\frac{1}{2}'' \times 1''$ and the cross rails are placed opposite the backings and coincide for fixing purposes. Bottom rails (at least in the side frames) are of wider stuff ($4'' \times 1''$) to stiffen them. Stiles are wrought on edges and face and the skeleton secured to the edges of face grounds and at cross rails to the backings. A $\frac{1}{2}''$ stop is then placed in the centre of jambs and soffit, nailed along the edges and at cross rails. The horizontal section at detail No. 141 B should be examined along with detail No. 142.

372. Finishings. The finishings in all the above cases consist of $4'' \times 1''$ splayed architraves to each side of the opening, mitred at angles and secured as described previously for external doors.

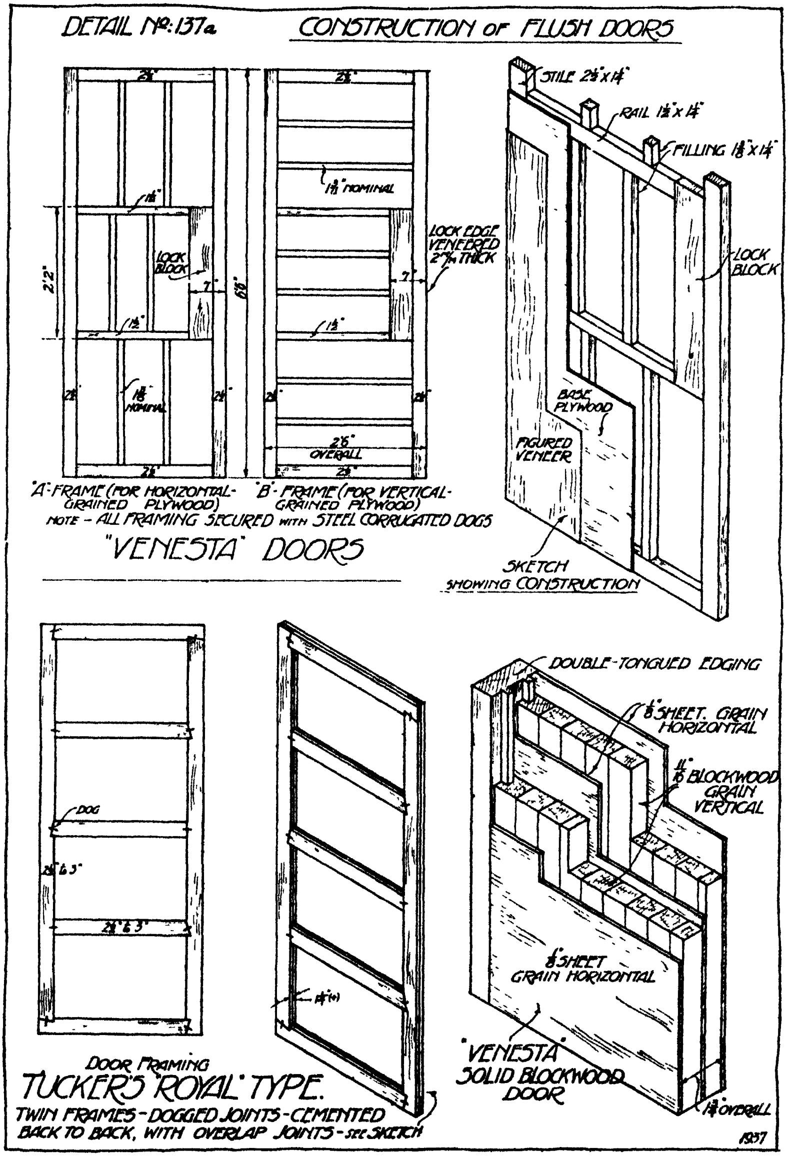


Special references. Details of jambs to larder, and cupboard under stair are shown in horizontal section at detail No. 139, and also of jamb to living room and scullery doorway.

Doors and finishings to ground floor are illustrated at details Nos. 137 and 143, where 2″ doors are employed with $1\frac{1}{2}'' \times \frac{5}{8}''$ flush moulds.

Jamb and soffit linings are here "tongued and grooved to the edges of the face grounds," which project the depth of the tongue from the "backings." These tongues ensure that the ground and lining keep flush on the edge and that the architrave lies flat upon them.

Such a joint may only be used to advantage with very dry, well seasoned linings, otherwise the lining may split through shrinkage.


DETAIL No: 137a
CONSTRUCTION of FLUSH DOORS
"A"-FRAME (FOR HORIZONTAL-GRAINED PLYWOOD)
"B"-FRAME (FOR VERTICAL-GRAINED PLYWOOD)
NOTE - ALL FRAMING SECURED WITH STEEL CORRUGATED DOGS
"VENESTA" DOORS
LOCK BLOCK
LOCK EDGE VENEERED
2'6" OVERALL
STILE
RAIL
FILLING
BASE PLYWOOD
FIGURED VENEER
SKETCH SHOWING CONSTRUCTION
DOUBLE-TONGUED EDGING
SHEET. GRAIN HORIZONTAL
BLOCKWOOD GRAIN VERTICAL
SHEET GRAIN HORIZONTAL
"VENESTA" SOLID BLOCKWOOD DOOR
DOG
Door Framing
TUCKER'S "ROYAL" TYPE.
TWIN FRAMES - DOGGED JOINTS - CEMENTED BACK TO BACK, WITH OVERLAP JOINTS - see SKETCH
1937

Description of Plates

Plates I and II—details Nos. 137 a and 137 b—show the construction of several types of modern flush door.

In general these doors present a perfectly flat face without any break or ornamentation other than can be obtained by the grain or pattern of the surface wood.

Whatever the form of framing, this framing is used as a base on which to lay—back and front—large sheets of plywood, which are cemented down to the framing under heat and pressure. The plywood—usually 3-ply as first prepared—may be of a plain wood suitable for painting, *e.g.* alder or birch, or for staining, *e.g.* Columbian pine, or the face may be veneered with matched pieces of selected grain in any of the ornamental hard-woods, such as oak, walnut, mahogany, teak, maple, etc.

The doors are normally of a finished thickness of $1\frac{3}{4}''$, with $1\frac{1}{4}''$ framing and two $\frac{1}{4}''$ plywood facings.

Door framing. According to the quality of door required, the framing may be mortice and tenon jointed as for the older types of doors of first-class construction, or, the units of the framing may be either square or bevel jointed and held together with steel corrugated jointing clips or dogs.

The latter method is used chiefly for the ordinary commercial quality of door and the resistance or rigidity of the finished structure depends chiefly upon the quality of the cement used in attaching the plywood facing and on the number of intermediate pieces of framing providing contact between frame and sheet.

In any case provision must be made for receiving lock and furniture and this is done either by using sufficiently wide stiles or by inserting special lock blocks on one or both sides, see details.

Examples of several forms of construction are given.

Venesta Doors. The framings for the Venesta standard types of door are shown in detail No. 137 a. The first (A) is an open framework with a lock block inserted on one side. The second (B) has numerous horizontal members which provide very adequate key for the cemented plywood. In both cases the framing is square butt jointed and assembled with steel clips, is then surfaced and the

face sheets applied. The sketch shows type A with the surface plywood overlaid with a figured veneer.

A special type of blockwood door made by the Venesta Company is also shown. It consists of two layers of $\frac{11}{16}''$ blockwood (sheets of board formed from selected strips glued edge to edge) with an interleaf of $\frac{1}{8}''$ material with the grain horizontal, and two similar sheets on the faces of the assembly. The edges of the door are closed by double-tongued edging strips. A well-made door of this type is very satisfactory and stable.

Tucker's Doors. The "Royal" type of door frame made by Messrs Tucker is shown in the same detail. It consists of twin frames laid back to back alternately square and bevel jointed—so that no complete end joint is square cut through the whole thickness—and is assembled with dogs or cleats.

The stiles are wide enough to take the modern type of small lock and furniture and can be adjusted to suit any requirement.

Tucker's blockwood door is shown in detail No. 137 b. The vertical strips are double tongued to form a base, the faces covered with plywood, and these overlaid with an ornamental veneer. Hardwood edge strips, rebated to receive the plywood and veneer and double tongued at the joints, are used to close the edges.

Solite Doors. In this case—detail No. 137 b—the framing consists of vertical strips, with packing pieces between in three rows—top, bottom and centre—forming what is termed open block construction. This forms a very good base on which to apply the facing plywood, succeeded by a figured veneer surfacing when desired.

Ripper Doors. Ripper doors are constructed with mortice and tenoned frames, which are independently stable and soundly assembled.

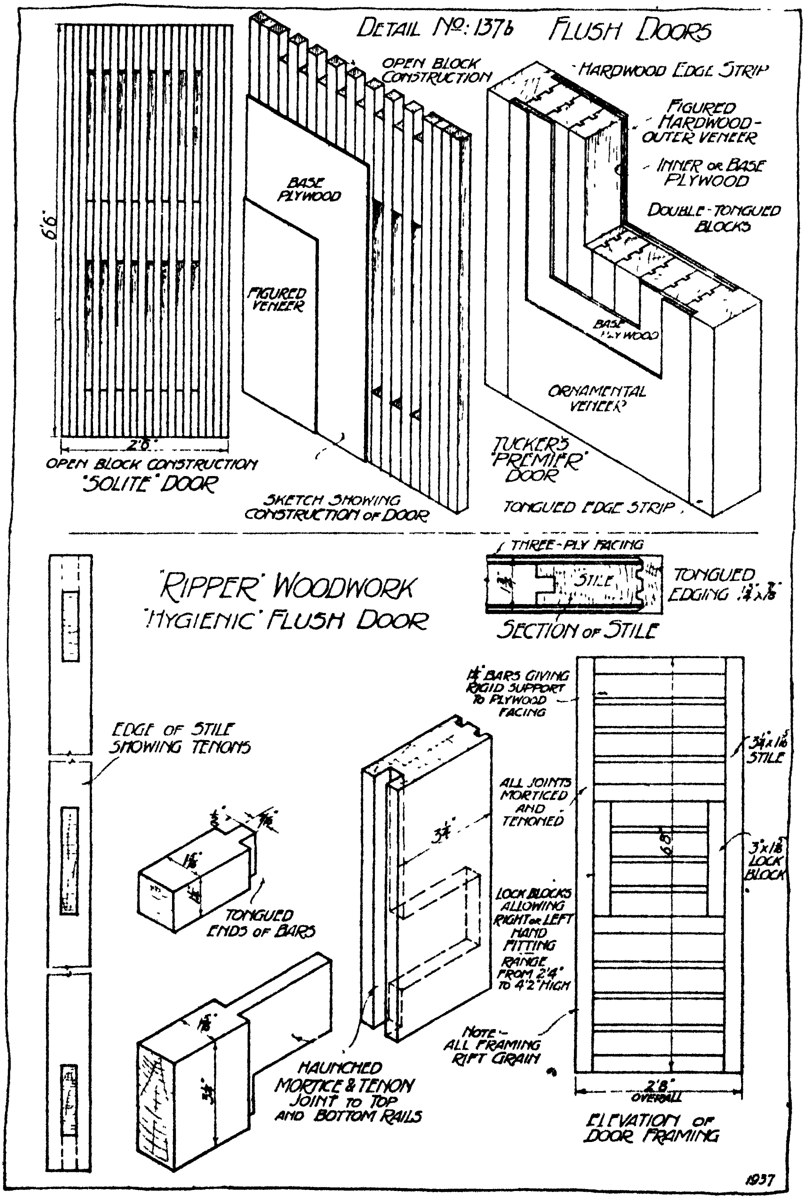
There are four main horizontal members all morticed and tenoned through the stiles and numerous lighter horizontal members are also stub tenoned to the stiles.

The facing sheets of plywood (and figured veneer where used) are cemented down and the edges prepared to receive a multiple-tongued slip. This slip has the outer tongues bevelled on the inside, and these clip the corresponding bevelled edge of the plywood facing and prevent it from curling outwards.

These doors are suitable for first-class work and are very dependable.

For ornamental veneered doors see Vol. II.

Plate II


DETAIL No: 137b FLUSH DOORS
OPEN BLOCK CONSTRUCTION
6'6"
2'6"
OPEN BLOCK CONSTRUCTION
"SOLITE" DOOR
BASE PLYWOOD
FIGURED VENEER
SKETCH SHOWING CONSTRUCTION OF DOOR
HARDWOOD EDGE STRIP
FIGURED HARDWOOD-OUTER VENEER
INNER OR BASE PLYWOOD
DOUBLE-TONGUED BLOCKS
BASE PLYWOOD
ORNAMENTAL VENEER
TUCKER'S "PREMIER" DOOR
TONGUED EDGE STRIP
THREE-PLY FACING
STILE
TONGUED EDGING
SECTION OF STILE
"RIPPER" WOODWORK
"HYGIENIC" FLUSH DOOR
EDGE OF STILE SHOWING TENONS
TONGUED ENDS OF BARS
HAUNCHED MORTICE & TENON JOINT TO TOP AND BOTTOM RAILS
BARS GIVING RIGID SUPPORT TO PLYWOOD FACING
ALL JOINTS MORTICED AND TENONED
LOCK BLOCKS ALLOWING RIGHT OR LEFT HAND FITTING RANGE FROM 2'4" TO 4'2" HIGH
NOTE - ALL FRAMING RIFT GRAIN
STILE
LOCK BLOCK
2'8" OVERALL
ELEVATION OF DOOR FRAMING
1937

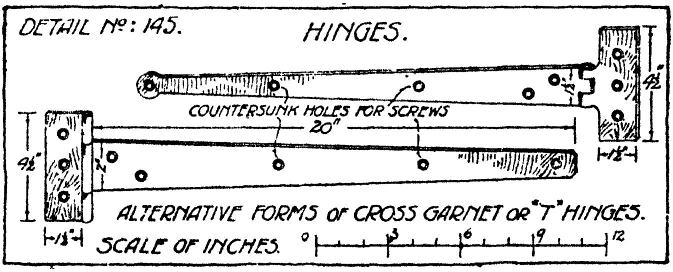
373. Jointing of linings. All linings to door openings, whether solid or of skeleton forms, should be tongued and grooved together at the angles. The soffit lining is grooved, and the jamb tongued, in the manner shown at detail No. 144. Tongues average ½″ square.

Door Fittings and Furniture

374. Fittings and furniture to doors include all that is necessary to complete the "hinging" and "securing in position" when closed.

These consist of hinges, latches and bolts, locks, knobs and handles, escutcheons and chains.

375. Hinges. A hinge is a metal pivot on which a door may swing about one of its edges; two at least are required to preserve equilibrium. Although almost all hinges of elementary form have the same "knuckle formation" about a "pin," the wings on which the knuckle is formed are shaped to suit the mode of attachment which the construction of the door demands.



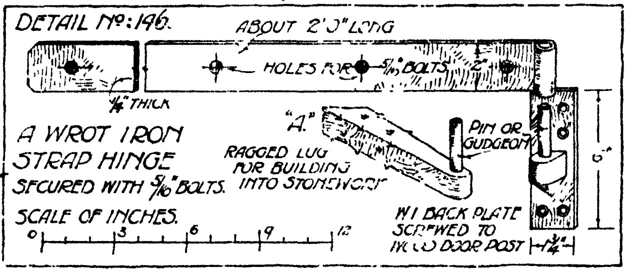
The hinges required for the doors illustrated in details of cottage and workshop should now be studied, and their suitability for the purpose in view noted.

If a door is composed of battens held together by ledges, a type of hinge which grips the length of the "ledge" across three or four battens is required. The "edge' of such a door is incapable of securely supporting it against drooping, hence a long hinge of the "strap" type is screwed on the face, opposite a ledge, and acts as a rigid bar across the battens, helping to retain them against "sag."

For battened doors therefore, hinges such as those detailed at No. 145, are suitable. Two forms are shown.

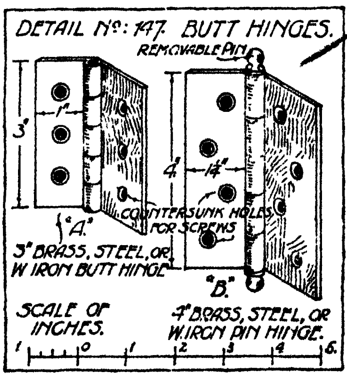
376. Cross garnet hinge. The cheapest hinge with a long band is the "cross garnet" or "T" hinge. One arm is 12″ to 20″ long, tapered from 2″ to about 1″ wide and ⅛″ thick, and is fixed to the door by strong screws; the other is 1¼″ to 1½″ long by 4″ to 6″ broad, and similarly secured to the narrow margin of the frame. It is applied in details Nos. 126 and 127 to the tool shed and E.C. doors of cottage.

377. Strap hinge. For framed and braced doors of large size, a stronger and better type of hinge should be employed, such as we have applied to the works entrance door in detail No. 130 and shown separately at No. 146. It is called a "strap hinge" or "band and hook," and, possessing a single knuckle, allows the door to be removed bodily from its hinges if the "hooks" are both set in the same direction.



The hinge consists of a wrought iron band $2'' \times \frac{1}{4}''$ about 2 ft. long, having a cylindrical eye formed at one end by bending the band round a $\frac{3}{8}''$ to $\frac{1}{2}''$ pin, and a hook or "gudgeon" for it to rotate upon is welded (or riveted) to a seating mounted on a $\frac{1}{4}''$ plate $2'' \times 5''$ or larger. The band is bolted through the rail of the door with $\frac{5}{16}''$ bolts and the gudgeon secured to the wooden frame with stout screws. The term "gudgeon," though commonly applied to the hook, is better reserved to the pin when prepared to fix into stonework, as in detail No. 146 at A; for this purpose it has a ragged dovetail end, which is socketed into a dovetail notch in the wall and run with lead and caulked.

378. Butt hinge. The simplest and most common hinge in use is the "butt" hinge, detail No. 147 A. It is used to pivot "any" solid framed door $1\frac{1}{4}''$ or more in thickness, and may be obtained in any length up to 6″.



Butt hinges are made in malleable iron, steel, brass and in brass wings mounted on steel pins. A variation of the butt hinge with a removable pin is shown at detail No. 147 B, and is known as a "pin" hinge. It would be applied to doors which have to be removed occasionally.

For light doors in painted work, such as ordinary house doors, steel plate butts are quite suitable,

two $3\frac{1}{2}''$ hinges being used for $1\frac{1}{2}''$ doors, and three $3\frac{1}{2}''$ or two $4''$ for $2''$ doors. For external and heavier doors "malleable butts" are often preferred, being stronger and thicker; they have wider bearing surfaces between the knuckles and do not allow "sagging due to wear" to occur so soon. A disadvantage is that the knuckle is large and ugly in appearance.

The common method of fitting a butt hinge is shown in sectional plan at detail No. 143. The wings are housed equally into door and frame (or lining), the centre of the pin being placed $\frac{1}{16}''$ clear of the door face so that the door edge swings clear on opening.

379. Latches. A latch is a fitting for temporarily securing a door in position, being automatically controlled by some form of lever. There are two forms. The "direct" or lifting latch, whose own weight keeps the "lift" in position, and the "spring" latch which is withdrawn by turning a knob.

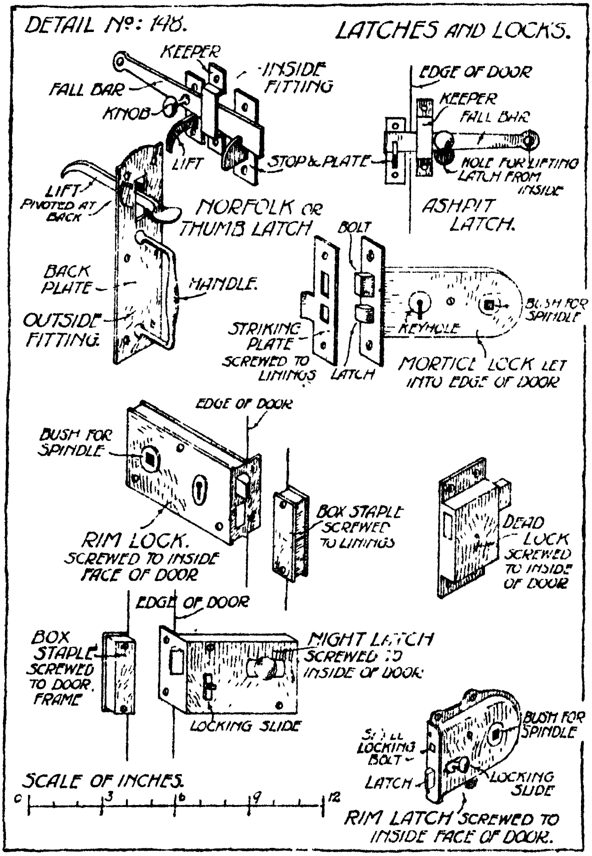
380. Norfolk latch. Direct lifting latches are suitably applied to outside use, on ledged and battened doors, their use being illustrated at detail No. 128. This type is variously known as a Norfolk, Suffolk or thumb latch. It consists essentially of a "fall bar" or "lever" pivoted on a small plate screwed to the "inside" of the door; the fall bar engages with a notched stop riveted to a plate which is screwed on the frame. The shape of the stop allows the latch to lift and drop into the notch when the door is pushed close, if it is correctly set and shaped. To prevent the bar from moving too far up or down, a "keeper" is placed over the fall bar at the correct height. A "knob" is provided, riveted to the bar, to lift it from within and on the outside is a "handle" mounted on a "back plate" and a "latch lift" or "sneck" for the thumb to press upon, which is passed through a mortice in the door and under the fall bar within.

Strong fittings only of this type are worthy of use, light and cheap kinds requiring frequent renewals. A detail of this fitting is shown at No. 148.

381. Modified forms of Norfolk latch. This type of latch is modified in form and strengthened for use in entrance gates, school and church doors and similar positions. It may, if care be given to the design, become an artistic fitting instead of the very ugly object so often used.

382. Ashpit latch. This consists of the "fall bar," "keeper" and "stop" of the Norfolk latch, without the lift and handle, and used only on the outside of unimportant doors, *e.g.* ash places, E.C.'s, etc., *where the door opens outwards.*—See details Nos. 126 and 148.

383. Spring latches. A spring latch is a light bar or bolt enclosed in a sheet metal case and kept protruding by a Y spring within. A square "spindle" is passed through a "bush" mounted between the plates, carrying projections which, on being turned, withdraw the bar against the spring; on being released the latch closes again by the force of the spring. These latches are prepared (*a*) to fix on



the *face* of a door, (*b*) to mortise into the *thickness* of a door. The former are called "rim" latches and the latter "mortice" latches. A "rim" latch is detailed at No. 148 and would be fixed to the bathroom door of cottage. This example has a small bolt added for securing the door from *within*. The same fitting might form an alternative for all the bedroom doors.

384. Locks. A "lock" provides a more or less permanent means of securing a door. It requires a "key" to actuate it, hence the means

of locking and unlocking may be removed when desired. "Rim" and "mortice" locks are available which are distinguished as in the case of latches.

385. Locks and latches are most often combined in *one* fitting and called a "two-bolt" lock. Detail No. 148 shows a "rim fitting" having an automatic latch controlled by the handle, and a "bevelled bolt" which engages with the "box staple" on pushing the door close; also a "dead bolt" actuated by a key. It may be either "latched only," or "locked" in addition. In the same detail is an example of a round-ended mortice lock, the only difference being that the latter is inserted in a mortice in the edge of the door.

386. Dead lock. A "dead" lock has no spring latch but the means of permanent security by key only, and is illustrated on detail No. 148.

Locks are prepared with keys long enough to pass into the fitting from either side of the door and a "key hole" or "slot" is necessary to admit this. Rim locks necessarily have long keys, while mortice locks have small neat keys. To prevent the key hole becoming worn at the edges and the surrounding area becoming disfigured, a "key plate" is placed over it, and if the plate has a pivoted cover attached to it, hanging pendant-like to close the key hole, the combination is called a "plate or drop escutcheon." This is applied in detail No. 137.

387. Lock keepers or staples are hollow metal boxes into which latches and lock bolts shoot; they are secured with long screws (see detail No. 148) and are only necessary for rim latches and locks.

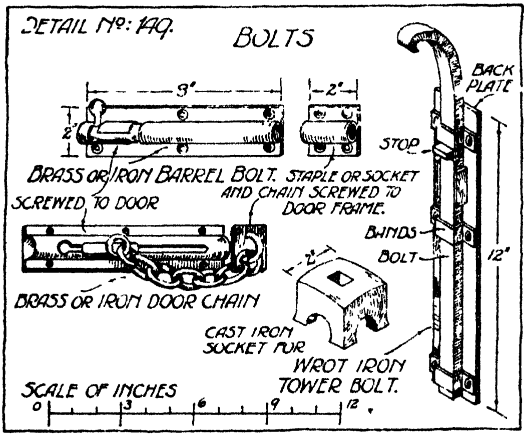
388. Striking plates. Mortice locks have slotted plates into which the bolts shoot; they are sunk into the jamb lining at the rebate, and surround mortices cut in the latter. One of these is shown along with the mortice lock on detail No. 148.

389. Furniture. The knob and spindle which all spring latches and combinations require are known as "lock furniture." The spindle is of square steel arranged for "adjusting" and "securing" the knobs which may be of wood, or porcelain bushed with brass, or of brass, gun-metal, or oxidised metal; see detail No. 137 for the form and application.

390. Finger plates form part of the furniture of a door and may be thin pieces of polished hardwood, shaped glass or porcelain, or ornamental metal plates, fixed as shown in detail No. 137 above and below the lock furniture, to protect the painted surface from finger marks.

391. Night latches. The main entrance door to a dwelling should be fitted with some form of night latch, one of which is illustrated at detail No. 148. It is a spring latch withdrawn by a knob sliding horizontally from within, and may also be turned by a key from outside. A small "locking slide" is provided which secures the latch in the position it occupies when the slide is moved vertically. The fitting is intended to be applied in the entrance door of cottage.

392. Door chain. A door chain is advantageously employed for securing a doorway from intrusion without closing the door properly; the chain carries a stud, which engages with a horizontal slot and may only be inserted with the door closed. The door may then be



opened a few inches, but the stud cannot be disengaged from the outside through the open door; a current of air may therefore be admitted with security.—See detail No. 149.

393. Barrel bolt. For the purpose of securing a door from within, a simple fitting known as a "barrel bolt" may be fixed on the inside of the door either horizontally or vertically. Detail No. 149 shows a barrel bolt which consists of a bar with a projecting knob, moving within a casing mounted upon a back plate and shooting into a short socket similar to the casing, or into a hole drilled in the hanging post and protected by a metal plate. These are commonly applied to all external doors near the top and bottom edges, in addition to other fittings.

394. Tower bolt. Is an alternative form of bolt where the bar slides within two or more "keepers" mounted on a back plate as shown in detail No. 149 for comparison with the barrel bolt.

A heavy form of this fitting is used later in the entrance gates to workshop yard.—See detail No. 172. When shaped for this position it is also termed a foot-bolt.

CHAPTER TWELVE

JOINERY

Windows and Finishings

395. A window is primarily a means of admitting light.

In this country, owing to atmospheric conditions, light may, as a rule, only be admitted through some weather resisting medium, and we invariably adopt some form of transparent glazing set in wood or iron frames provided for this purpose; the "whole" or some "convenient part" of the glazed area should be capable of speedy opening when desired.

Our present purpose is to study the construction of the wooden frames containing the glazing, or appurtenant thereto.

396. Frames and sashes. The term "window" is commonly used to describe the nature of the wooden frame (or frames) in which the glazing is placed and opening parts arranged.

There are many methods of arranging for parts to open, but in most cases the window consists of a "frame" and a "sash." A window "frame" is the prepared margin within which the "sash" is set, and the latter invariably means that portion of the woodwork into which the glazing is secured.

397. Kinds of frames. Frames are of two kinds, "solid" and "cased."

Solid frames vary in size from $3\frac{1}{2}'' \times 3''$ to $5'' \times 4''$ and are rebated to receive the sashes.

Cased frames are usually "boxings" or "casings" made from *thin* material and are exclusively used for "sliding sashes." These casings are of material $1''$ to $1\frac{1}{2}''$ thick.

Sashes are light framings from $1\frac{1}{2}''$ to $2\frac{1}{2}''$ thick, according to their size and purpose.

398. Kinds of window. "Kinds" of window are described by the treatment of the sash. Sashes may be either fixed, hung on the vertical edges like doors, hung on the horizontal edges, pivoted centrally through their vertical edges, or made to slide vertically or horizontally. The following definitions cover only such types of window as have been used in the cottage and workshop we are studying.

(1) *Fixed sashes.* These are fitted into solid frames and permanently secured. In some parts of the North of England fixed sashes are used without frames.

(2) *Casement sashes* are made to rotate upon hinges attached to one edge of the sash and frame. We shall study two kinds, viz.

casements of the common type, hung on their vertical edges like doors, and "top hung" casements, hinged on their top edges and opening outwards as applied in the workshop windows.

(3) *Pivoted sashes.* These are made to rotate about a horizontal axis near the centre of their height by means of "pivots" or "centres" fixed in the vertical edges of sash and frame.

(4) *Vertical sliding sashes* have the sashes arranged between "casings" or "hollow boxings," the latter enclosing weights which balance the sashes and allow easy vertical movement along slides or grooves provided for the purpose.

These are probably in greatest demand for cottage building and in exposed situations and are easily made weather proof.

399. Relative advantages of the above kinds of windows. Because the extent to which window sashes may be opened is the chief means of controlling changes of air in the rooms of dwelling houses and workshops, the value of each type of window sash for this purpose is important.

"Fixed" windows allow of no ventilation and if one window only is used to light a room "it should never be fixed."

Casements will allow the whole area of the casement portion to be opened "fully," and, if desired, the entire opening may be arranged as a casement. Sunny rooms need such windows. "Top-hung" casements cannot be conveniently opened to the full extent. The "free edge" rotates through an angle seldom exceeding 30°, and special means of "opening" and "staying" are required.

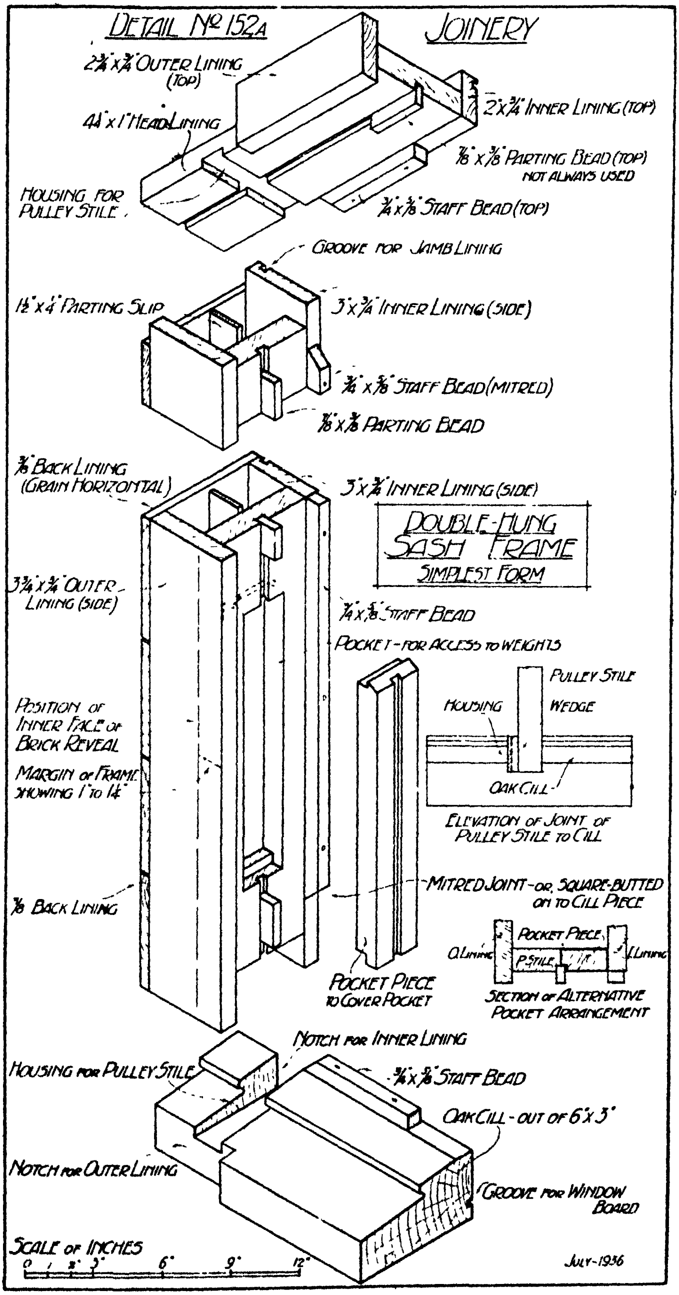
"Pivoted sashes" are conveniently regulated to have either a very small area of opening or the full extent of the sash. They must, however, be open at top and bottom edges equally and simultaneously.

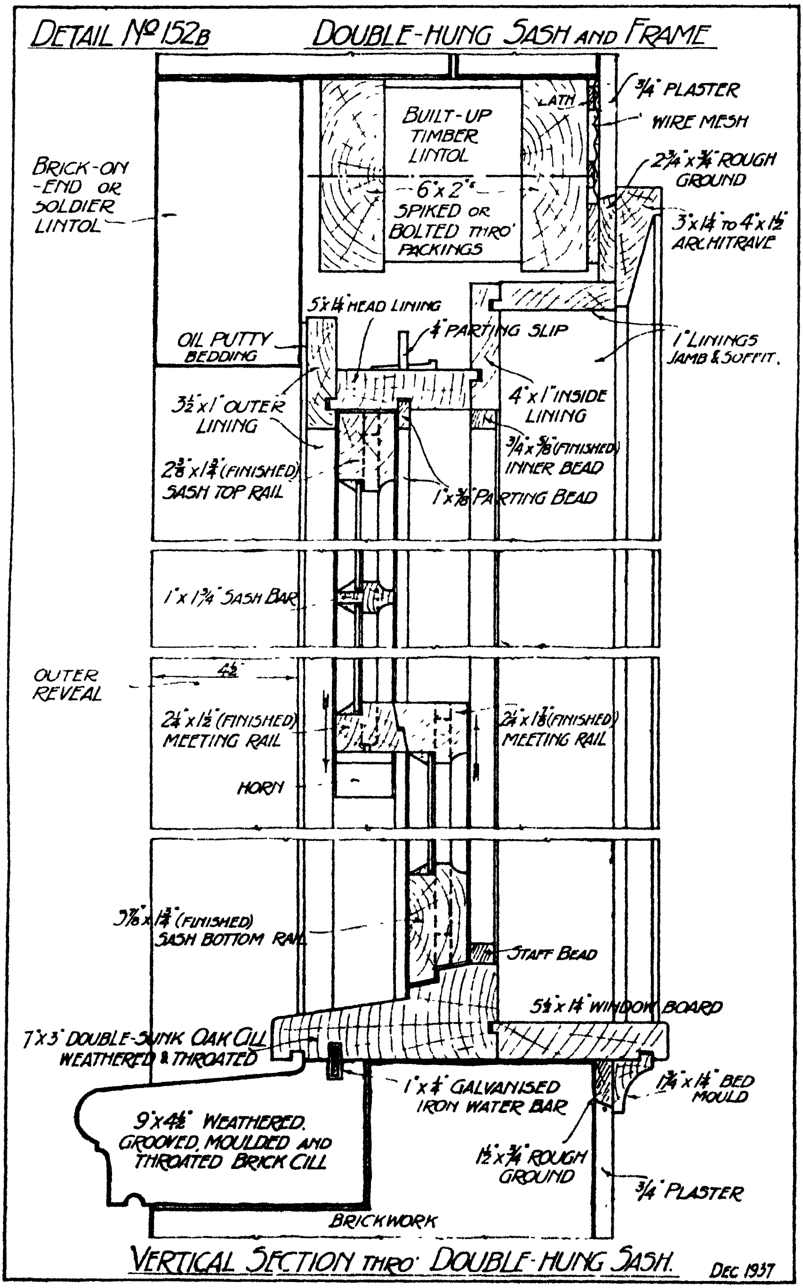
"Vertical sliding sashes," at the maximum, allow one half of the opening to be clear, this being possible when the sashes are each of half the height. Opening may be secured at the top or bottom, or both, and when either sash is open air enters also at the centre between the meeting rails.

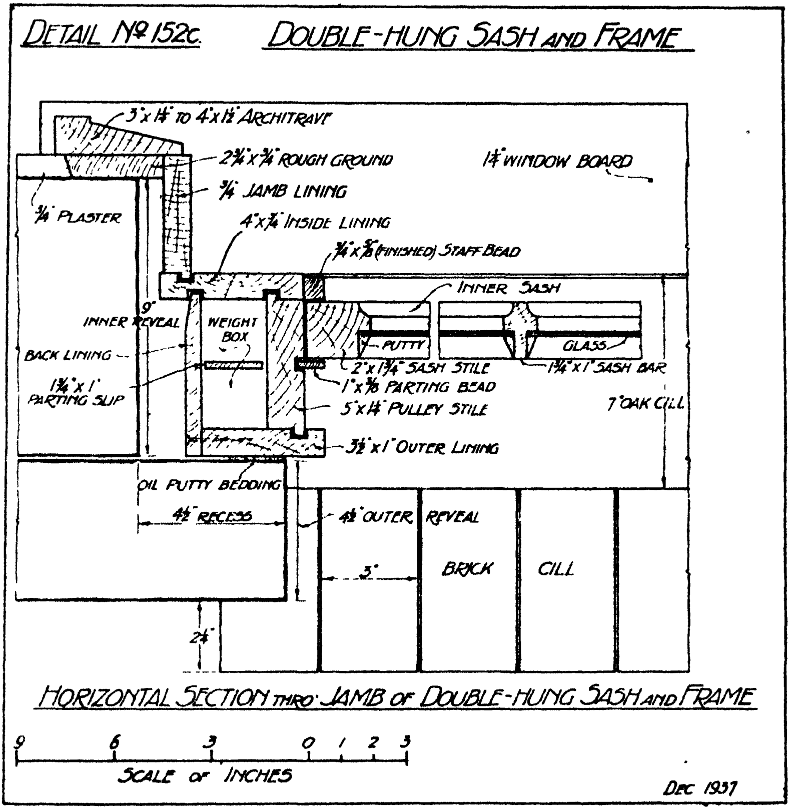
400. Size of windows. The dimensions of a window are expressed in terms of the height and width of its opening, measured vertically between top of cill and soffit of lintol, and horizontally between the reveals. If arched, the height is measured to the springing line.

The total area of windows—nett measure of glazing—should be from $\frac{1}{10}$ to $\frac{1}{7}$ of the floor area of the room they illuminate.

401. Recessed jambs. Most window openings are provided with recessed jambs, with reveals $4\frac{1}{2}''$ broad and recess $2\frac{1}{4}''$ to $4\frac{1}{2}''$ deep. In our examples we have adopted $2\frac{1}{4}''$ recesses for "solid frame" windows, and $4\frac{1}{2}''$ for "cased frames and sliding sashes."


DETAIL Nº 152A
JOINERY
2¾"x¾" OUTER LINING (TOP)
4½"x1" HEAD LINING
2"x¾" INNER LINING (TOP)
⅞"x⅜" PARTING BEAD (TOP) NOT ALWAYS USED
HOUSING FOR PULLEY STILE
¾"x⅞" STAFF BEAD (TOP)
GROOVE FOR JAMB LINING
1½"x¼" PARTING SLIP
3"x¾" INNER LINING (SIDE)
¾"x⅞" STAFF BEAD (MITRED)
⅞"x⅜" PARTING BEAD
⅜" BACK LINING (GRAIN HORIZONTAL)
3"x¾" INNER LINING (SIDE)
DOUBLE-HUNG SASH FRAME
SIMPLEST FORM
3¾"x¾" OUTER LINING (SIDE)
¾"x⅞" STAFF BEAD
POCKET - FOR ACCESS TO WEIGHTS
PULLEY STILE
HOUSING
WEDGE
OAK CILL
ELEVATION OF JOINT OF PULLEY STILE TO CILL
POSITION OF INNER FACE OF BRICK REVEAL
MARGIN OF FRAME SHOWING 1" TO 1¼"
MITRED JOINT - OR, SQUARE-BUTTED ON TO CILL PIECE
⅜ BACK LINING
POCKET PIECE
O.LINING
P.STILE
I.LINING
POCKET PIECE TO COVER POCKET
SECTION OF ALTERNATIVE POCKET ARRANGEMENT
NOTCH FOR INNER LINING
HOUSING FOR PULLEY STILE
¾"x⅞" STAFF BEAD
OAK CILL - OUT OF 6"x3"
NOTCH FOR OUTER LINING
GROOVE FOR WINDOW BOARD
SCALE OF INCHES
0 1 2 3" 6" 9" 12"
JULY-1936


DETAIL No 152B
DOUBLE-HUNG SASH AND FRAME
3/4" PLASTER
LATH
WIRE MESH
BUILT-UP TIMBER LINTOL
6"x2"s SPIKED OR BOLTED THRO' PACKINGS
BRICK-ON-END OR SOLDIER LINTOL
2 3/4"x3/4" ROUGH GROUND
3"x1 1/4" TO 4"x1 1/2" ARCHITRAVE
5"x1 1/4" HEAD LINING
1/4" PARTING SLIP
OIL PUTTY BEDDING
1" LININGS JAMB & SOFFIT.
3 1/2"x1" OUTER LINING
4"x1" INSIDE LINING
3/4"x5/8" (FINISHED) INNER BEAD
2 3/8"x1 3/4" (FINISHED) SASH TOP RAIL
1"x7/8" PARTING BEAD
1"x1 3/4" SASH BAR
OUTER REVEAL
4 1/2"
2 1/4"x1 1/2" (FINISHED) MEETING RAIL
2 1/4"x1 1/8" (FINISHED) MEETING RAIL
HORN
3 7/8"x1 3/4" (FINISHED) SASH BOTTOM RAIL
STAFF BEAD
5 1/2"x1 1/4" WINDOW BOARD
7"x3" DOUBLE-SUNK OAK CILL WEATHERED & THROATED
1"x1/4" GALVANISED IRON WATER BAR
1 3/4"x1 1/4" BED MOULD
9"x4 1/2" WEATHERED, GROOVED, MOULDED AND THROATED BRICK CILL
1 1/2"x3/4" ROUGH GROUND
3/4" PLASTER
BRICKWORK
VERTICAL SECTION THRO' DOUBLE-HUNG SASH.
DEC 1937



DESCRIPTION OF PLATES

Plate III—detail No. 152 A—shows the simplest form of construction for a double-hung sash frame. There are no tongued joints between the linings and no mouldings to confuse the student on first approaching this problem in joinery. From the isometric view given, with the aid of references to details Nos. 153 to 156, sectional working drawings should be made.

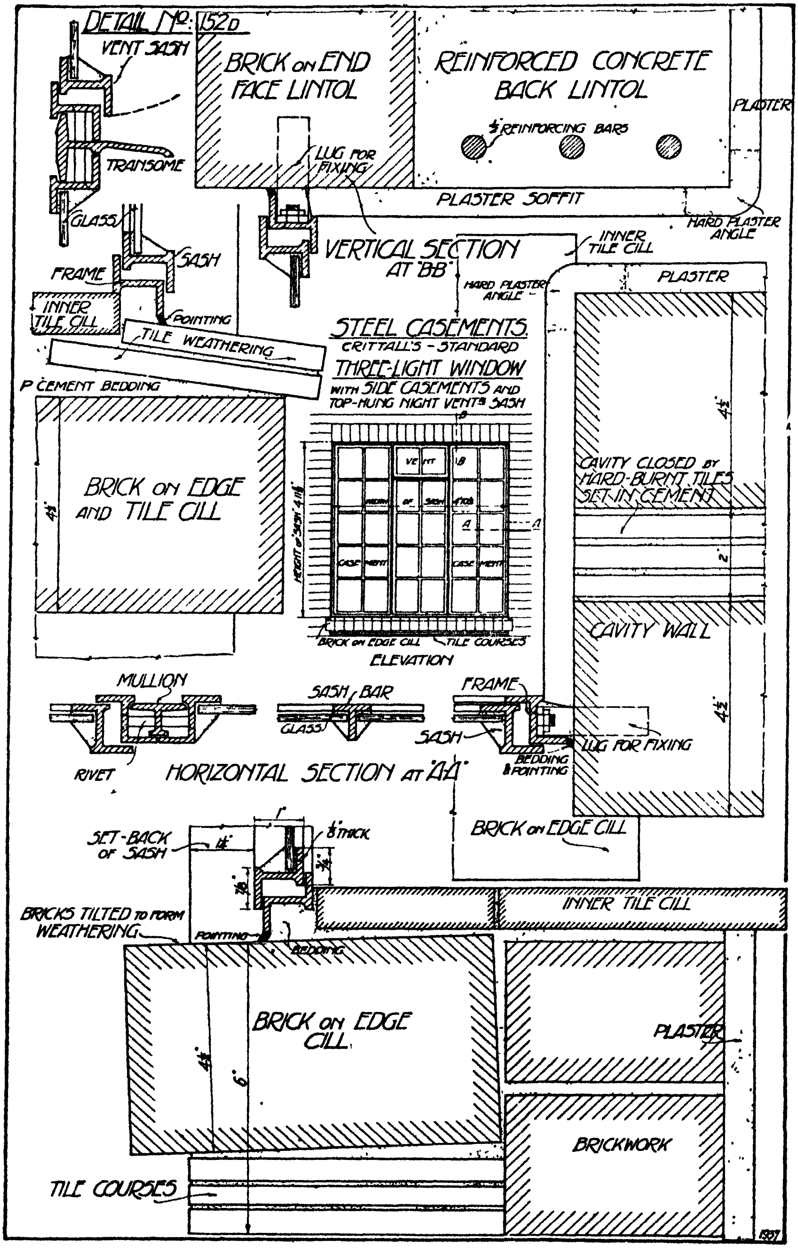
Plates IV and V—details Nos. 152 B and C—show a vertical and a horizontal section of a better construction with tongued linings, but in all other respects comparing in simplicity with Plate III. Details of the tongued joints should be prepared after the simple assembly in Plate III has been thoroughly understood.

Variations in the treatment of the lintols and cills from those given in details Nos. 153 onwards should also be noted.

Plate VI—detail No. 152 D—shows a modern three-light steel sash frame with two casement side lights and a night ventilator at the head of the centre light. The method of building up the three lights—see mullion—and the methods of securing the frame to the jambs and making the surround watertight are shown in the diagram. Alternative forms of cill with brick and tile construction are also given.

A modern reinforced concrete back lintol is indicated and also a method of filling the cavity of a hollow wall and making solid and watertight.

PLATE VI

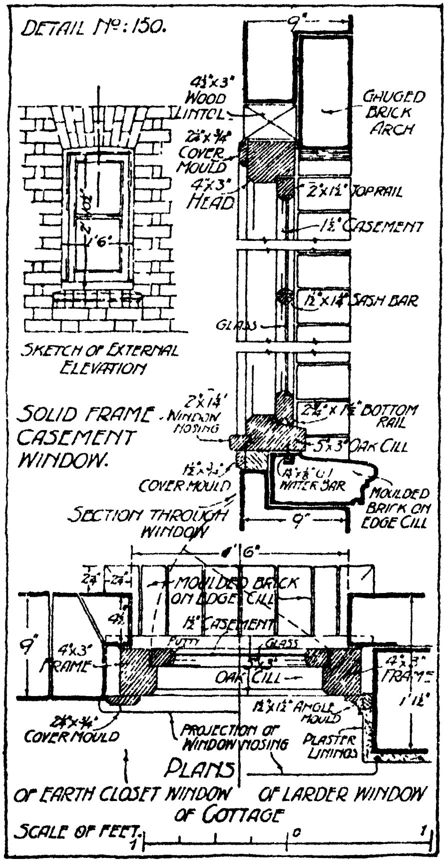


DETAIL No. 152D
VENT SASH
TRANSOME
GLASS
SASH
FRAME
INNER TILE CILL
POINTING
TILE WEATHERING
P CEMENT BEDDING
BRICK ON END FACE LINTOL
LUG FOR FIXING
REINFORCED CONCRETE BACK LINTOL
½ REINFORCING BARS
PLASTER
PLASTER SOFFIT
HARD PLASTER ANGLE
VERTICAL SECTION AT "BB"
INNER TILE CILL
HARD PLASTER ANGLE
STEEL CASEMENTS.
CRITTALL'S - STANDARD
THREE-LIGHT WINDOW
WITH SIDE CASEMENTS AND TOP-HUNG NIGHT VENTS SASH
BRICK ON EDGE AND TILE CILL
CAVITY CLOSED BY HARD-BURNT TILES SET IN CEMENT
CAVITY WALL
BRICK ON EDGE CILL
TILE COURSES
ELEVATION
MULLION
RIVET
SASH BAR
GLASS
FRAME
SASH
LUG FOR FIXING
BEDDING & POINTING
HORIZONTAL SECTION AT "AA"
BRICK ON EDGE CILL
SET-BACK OF SASH
⅛" THICK
BRICKS TILTED TO FORM WEATHERING
POINTING
BEDDING
INNER TILE CILL
BRICK ON EDGE CILL
PLASTER
BRICKWORK
TILE COURSES

402. Solid frames. The solid frame of a window is continued all round the opening. Similar terms are employed as for door frames, viz. side pieces are called "stiles" or "posts," the top a "head" and the additional member at the base of the opening a "cill." In connection with each window we have, therefore, a brick, stone, or tile cill forming the weathering surface to the opening (as explained in previous chapters) and a "wooden cill to the frame" which is seated upon the former; in good work the latter should invariably be of "oak" or other durable hard wood.

WINDOWS TO COTTAGE

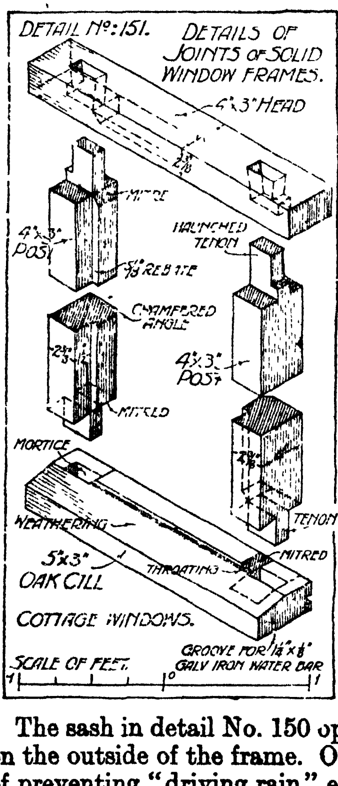
403. E.C. and larder windows. In detail No. 150 is given the external elevation, also vertical and horizontal sections of the "E.C." and "larder" windows to cottage, and in detail No. 151 the isometric view shows the method of assembling the parts of the solid frame. The method of this jointing is: "to *tenon* the stiles and to *mortise* the head and cill." The reason for this, is to secure an unbroken weathering surface to the cill from end to end (so far as this is possible) and from the sketch it may be seen that the shoulders on the stiles are bevelled to fit the "cill weathering." This is referred to as "scribing the post to the cill." Further, the square shoulders on the posts provide a good support for the ends of the head, and any load it carries.

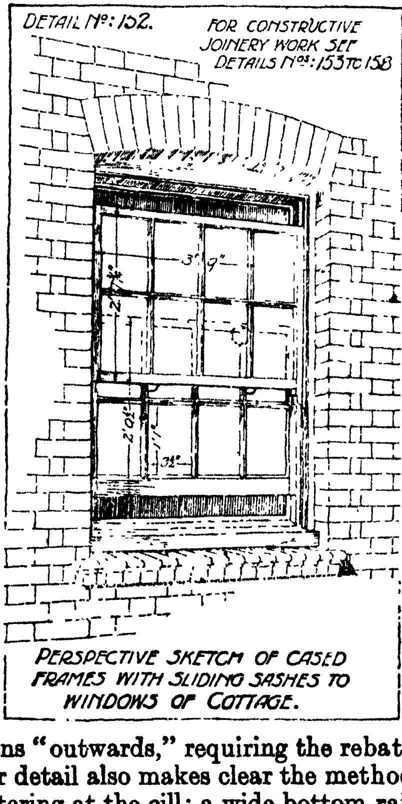


Notice specially the arrangement of the joints. The head and cill are left longer than ultimately required and haunched tenons to all joints are adopted in order to allow "secure wedging." When placed in the opening the

long ends of the head and cill are cut to fit neatly between the jambs and the frame is wedged into position at the head by folding wedges laid immediately over the stiles.

404. Bedding of frames. Solid frames are bedded in oil putty round the margin of the brick recess, and the cill connection is rendered weathertight by a 1″ × ¼″ galvanised iron "water-bar" for which you will remember that brick and stone cills were prepared (see Chapter Three, page 46).





The sash in detail No. 150 opens "outwards," requiring the rebate on the outside of the frame. Our detail also makes clear the method of preventing "driving rain" entering at the cill; a wide bottom rail is used in the sash which is deeply grooved along the centre of the bottom edge to prevent capillary action[1], and the wood cill is throated at the top of its sunk and weathered surface. In addition the wood cill projects within the reveal 1″, thus overlapping and protecting the sinking at the commencement of the brick weathering.

[1] See Manson's *Building Science*, Vol. I.

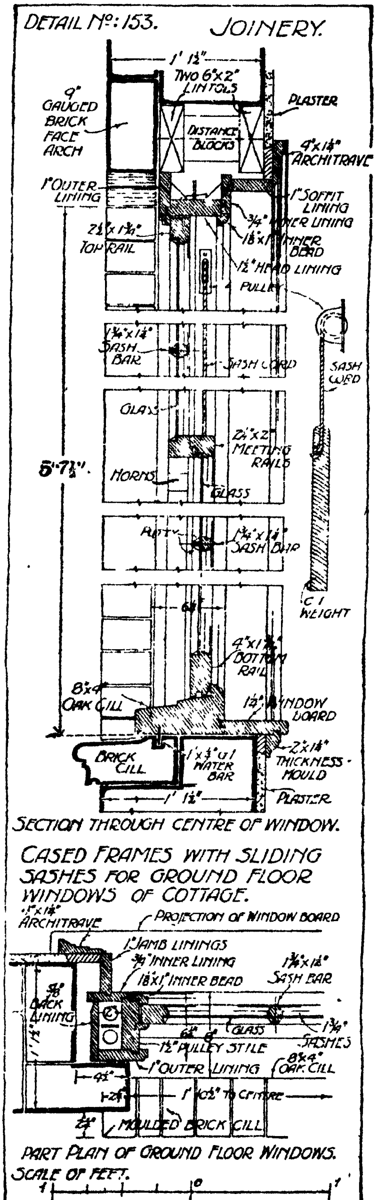
To arrange the elevation of such a window with an arched head, the "minimum lap of the frame" into the recess at the "crown" of the arch must be $1\frac{1}{4}''$ and the plain head made deep enough to enclose the rise of the arch.

405. Casement sash. The sash of detail No. 150 is of the true casement form, hinged on one vertical edge. It consists of vertical stiles and horizontal top rail, with a deep bottom rail to obtain *wider* shoulders and thereby a *stiffer* sash. All casements should be treated in this way. Stiles and head should be kept as light as practicable in order to admit the maximum of light. In this case stiles and top rail are $2'' \times 1\frac{1}{2}''$ and the bottom $2\frac{3}{4}'' \times 1\frac{1}{2}''$.

406. Vertical sliding sashes and cased frames[1]. These are generally arranged as a pair of equal-sized sashes both of which may be moved vertically in grooves formed in the frame, details of which may be largely varied according to quality of work required and the personal desire of the designer.

Sashes are said to be "double hung" when both are balanced and made to open, and "single hung" if only one is balanced and the other screwed permanently to the casing.

Single-hung sashes are not to be recommended; they present greater difficulties in cleaning and also disadvantages in ventilation. Usually the lower sash is movable, which means that no "top opening" is available, yet an opening near the top of a room is a great essential in a scheme of ventilation.



SECTION THROUGH CENTRE OF WINDOW.

CASED FRAMES WITH SLIDING SASHES FOR GROUND FLOOR WINDOWS OF COTTAGE.

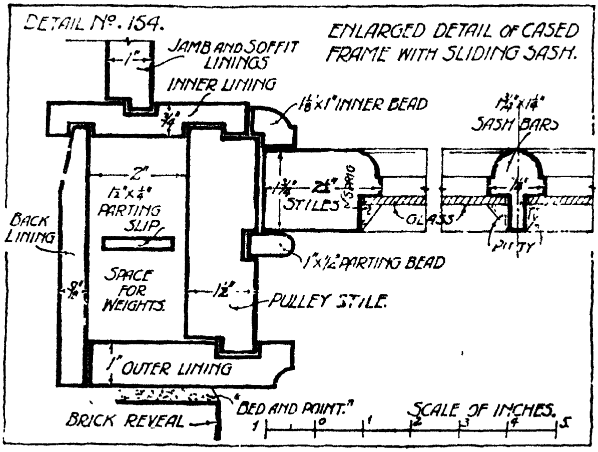
PART PLAN OF GROUND FLOOR WINDOWS.

SCALE OF FEET.

[1] The text in pages 211 to 217 deals with the design and construction of a double-hung sash and frame of the best quality. Simpler forms of design and construction are given in Plates III to V. A steel sash of modern type suitable for the cottage is also given in Plate VI.

The construction of a double hung sash and frame needs the most careful thought on the part of the student, and its general appearance is shown in the perspective sketch, detail No. 152.

407. Cased frame. Considering the frame first, we find that the mode of balancing the sashes commonly adopted calls for a "boxed" or "cased" frame, which is built up from comparatively thin material. The mode of balancing consists of suspending the sashes by attaching hemp cords to them at their vertical edges and passing these over pulleys housed into the head of the member against which the sash slides; balance weights are connected to the cords, and are contained in the boxes behind the recess of the opening.

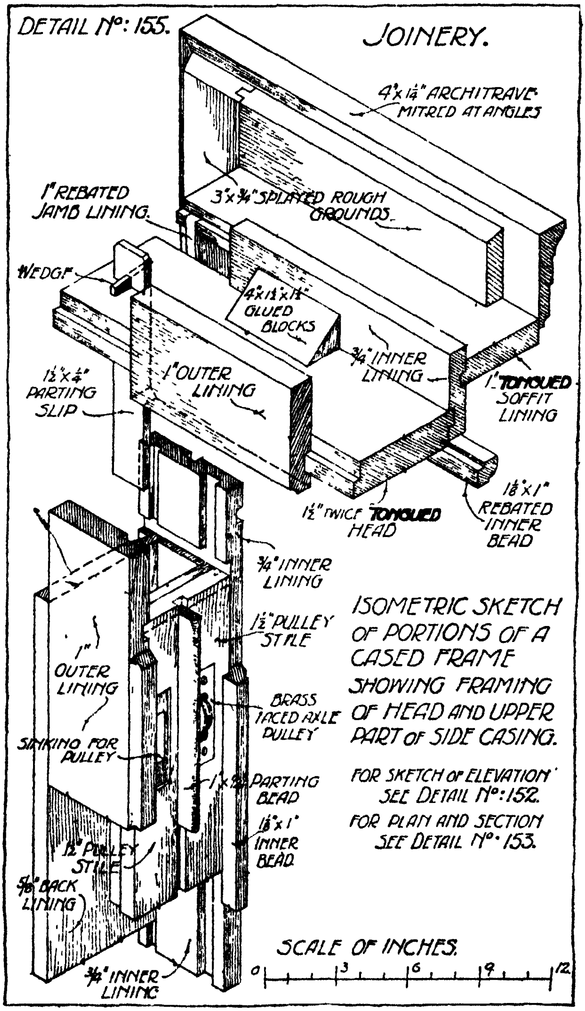


Dealing with the frame in detail, its main parts are:—"cill"—bottom horizontal member, "head"—top member, "pulley stiles"—the vertical members carrying the pulleys for the sash cords. Head and pulley stiles are generally identical in shape and size.

408. Sizes of parts. The dimensions of these parts are: "cill," from 6" × 3" to 8" × 4", and preferably of oak; "pulley stiles and head," 4½" × 1" to 5" × 1¼" or wider if thicker sashes are used. The sizes in detail No. 156 are 8" × 4" cill and 4¾" × 1¼" pulley stiles.

409. Arrangement of frame. The pulley stiles are placed between the cill and head, in such a position as to project ¾" within the opening at each side and are "housed" into these members at head and foot. A portion of the oak cill projects over the brick cill as in previously considered frames and the ends of the horizontal pieces pass forward to the face of the recessed jambs; between these entrant portions of cill and head the "case" for receiving the balance weights is formed by covering the front and back edges of the pulley stiles

with "outer" and "inner linings," 1" and ¾" thick respectively, as in detail No. 154, both being of the same width, but the "outer" overlapping the pulley stile ⅝" to ¾" within the opening, thus forming



part of the sash slide, while the inner one is either kept "flush" or ¼" back from the face of the pulley stile.

The box is completed by a ½" to ¾" "back lining," which is grooved into the inner lining, and nailed against the edge of the outer one.

In good work all these parts are tongued together as shown in section at details Nos. 153 to 156, but in cheap work they are made of the smaller sized materials referred to above and nailed together with square joints.

The details of component parts of the frame, with their joints, are shown grouped at details Nos. 155 and 156. Joints are nailed together at intervals along the tongued and grooved edges and housings, the joint between pulley stile and cill being housed, side wedged, and nailed.

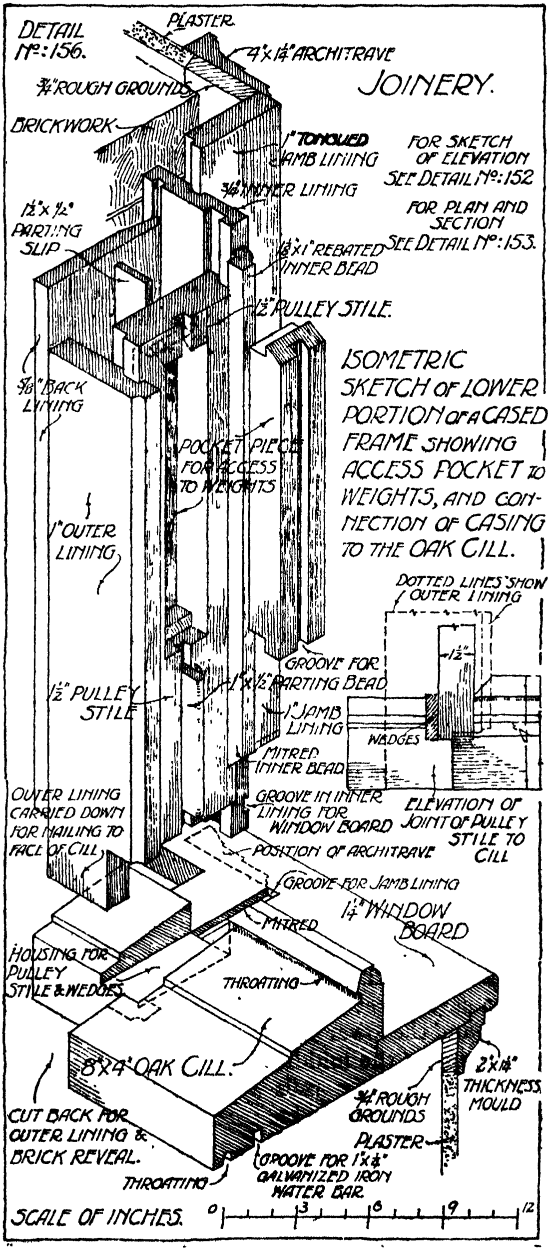
Outer and inner head linings are necessary to complete the casing, largely for surfacing purposes. Because they stand a considerable distance above the head (see vertical section) triangular blocks are glued in the inside angles to keep them rigid.—Details Nos. 153 and 155.

Within the "weight case" is shown a strip of hard wood, $1\frac{1}{2}'' \times \frac{1}{4}''$, hung from the head through a mortice, and suspended by a wooden wedge or nail. This strip is termed a "parting slip" or "mid feather"; its function is to prevent noise by metal weights knocking against each other when the sashes are quickly moved.—See details Nos. 154, 155 and 156.

410. Pulleys. Sash pulleys are grooved for the cord, and mounted in malleable iron, gun metal or steel cases which are flanged for housing and screwing into position 3″ to 4″ from the head of the stile. These pulleys have their grooves slightly projecting into the opening so that the cords hang vertically; they are attached to the sash by grooving its stiles 10″ to 12″ down, nailing 6″ of length of the cord at the extreme end and leaving the remainder free to pass the pulley over which the groove enables the sash to travel. The back edge of the pulley must overhang $\frac{7}{8}''$ to 1″ (measured at the groove) into the weight case, to allow the weight to hang vertically and so avoid bearing against the stile. Thus, the diameter of the pulley is determined by the thickness of the stile, $1\frac{3}{4}''$ diameter being the least suitable for a stile $\frac{7}{8}''$ thick while for our case, having a $1\frac{3}{8}''$ finished thickness, $2\frac{1}{4}''$ pulleys would be needed. Detail No. 153 shows the pulley in correct position.

411. Cill. The cill is sunk, weathered and throated, of 8″ × 4″ oak, and comparable with previous details except that it is "double sunk." Its outer sinking should commence near the face of the lower sash, which greatly assists the joint to repel water.

412. Sash slides. Now observe the provision made for the reception, enclosing and removal of the sashes. We have already noticed the protrusion of the outer lining to form one side of a groove. To form *two* grooves, a central division is inserted in the form of a $1'' \times \frac{3}{8}''$ (or $\frac{1}{2}''$) parting bead grooved into the pulley stile and closely fitted. It is removable for inserting and removing the sashes, passes along a "pocket piece" arranged in the stile for access



DETAIL Nº: 156.
JOINERY.
PLASTER
4"x 1¼" ARCHITRAVE
¾" ROUGH GROUNDS
BRICKWORK
1" TONGUED JAMB LINING
FOR SKETCH OF ELEVATION SEE DETAIL Nº: 152
¾" INNER LINING
FOR PLAN AND SECTION SEE DETAIL Nº: 153.
1½"x ½" PARTING SLIP
1⅜"x 1" REBATED INNER BEAD
1½" PULLEY STILE.
ISOMETRIC SKETCH OF LOWER PORTION OF A CASED FRAME SHOWING ACCESS POCKET TO WEIGHTS, AND CONNECTION OF CASING TO THE OAK CILL.
⅝" BACK LINING
POCKET PIECE FOR ACCESS TO WEIGHTS
1" OUTER LINING
DOTTED LINES SHOW OUTER LINING
GROOVE FOR PARTING BEAD
1½" PULLEY STILE
1"x ½" PARTING BEAD
1" JAMB LINING
WEDGES
MITRED INNER BEAD
OUTER LINING CARRIED DOWN FOR NAILING TO FACE OF CILL
GROOVE IN INNER LINING FOR WINDOW BOARD
ELEVATION OF JOINT OF PULLEY STILE TO CILL
POSITION OF ARCHITRAVE
GROOVE FOR JAMB LINING
1¼" WINDOW BOARD
MITRED
HOUSING FOR PULLEY STILE & WEDGES
THROATING
8"x 4" OAK CILL.
2"x 1¼" THICKNESS MOULD
¾" ROUGH GROUNDS
CUT BACK FOR OUTER LINING & BRICK REVEAL.
PLASTER
GROOVE FOR 1"x ⅛" GALVANIZED IRON WATER BAR
THROATING
SCALE OF INCHES. 0 3 6 9 12

to the weight case and secures the same in position. The pocket piece is necessary to allow access to the weights for cord renewals, and is shown in detail No. 156.

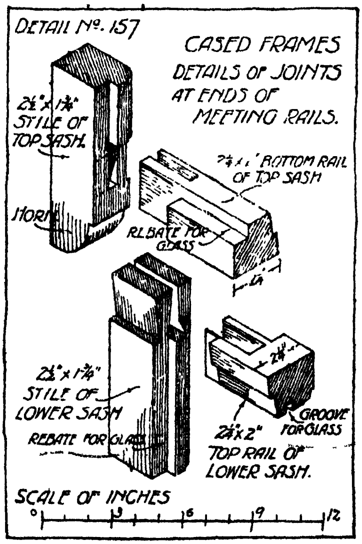
At the inside lining a $1\frac{1}{8}'' \times 1''$ rebated ovolo mould forms what is known as the "staff" or "inner" bead. This is "bradded," or better, "screwed," to the lining, allowing removal when required.

Note. In cheaper work, where the pulley stile and lining are flush on the inner edges, a $\frac{7}{8}'' \times \frac{5}{8}''$ staff bead (in form like a loose glazing bead) is mitred round the frame on stiles, head and cill, in place of the ovolo mould. In our example the cill is rebated in the solid and this takes the place of a loose inner bead.

413. Sashes. The sashes are $1\frac{3}{4}''$ thick, made of equal height, overlapping each other at the centre by the width of their meeting rails (see vertical section of detail No. 153) and are made to fit their slides *easily* but not *loosely*.

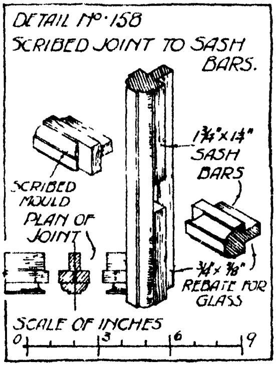
The dimensions adopted are: $2\frac{1}{2}'' \times 1\frac{3}{4}''$ stiles and top rail, $2\frac{1}{4}'' \times 2''$ meeting rails (allowing for rebate), $4'' \times 1\frac{3}{4}''$ bottom rail (of oak) and $1\frac{3}{4}'' \times 1\frac{1}{4}''$ sash bars. Constructional detail, as a whole, is on the same principle as in previous examples of sashes. Although the degree of rigidity required for a casement is unnecessary for a sliding sash—because of the uniform suspension adopted—it is wise to accept such arrangement of the members as will give a rigid and reliable sash, so that the sash is not deformed before it is glazed.

414. Rigidity of sashes. A "deep bottom rail" is employed in the lower sash, jointed by a wedged "haunch tenon"; the width of shoulder secures rigidity. In the top sash the stiles are allowed to project $2\frac{1}{2}''$ to $3''$ below the meeting rail, forming a "horn" usually shaped to a bracket outline; firm wedging is again possible with consequent "stiffness."



415. Position of sashes. The positions occupied by the sashes should be carefully noted. In all cases the upper sash is set within the outer groove, and the lower sash inside it overlapping at the middle rails. At this overlap these rails (called "meeting rails") have to be made wider to span the space caused by the parting bead dividing the sashes. This is clear from the vertical section at detail No. 153 and also in the isometric details at No. 157.

416. Sash joints. The last named details also show how the jointing is executed at the "base angle of the upper sash" and the "top angle of the lower sash," embodying "tenon and housing" in the first case and "dovetailing" in the second. From the section it will be seen that the meeting rails are "bevel rebated" together, enabling the sashes to clear quickly; the housing of the meeting rail joints ensures that no "feather edge" occurs at the notch which you will see is formed to clear the parting bead.



A "horn" is sometimes provided at the "head of the lower sash." We do not approve of this; it is unnecessary for strength when a deep bottom rail is used and detracts from the appearance; a dovetailed joint and level finish is preferable.

Sash bars are jointed by halving and mitreing, or may be tenoned and scribed, as in detail No. 158.

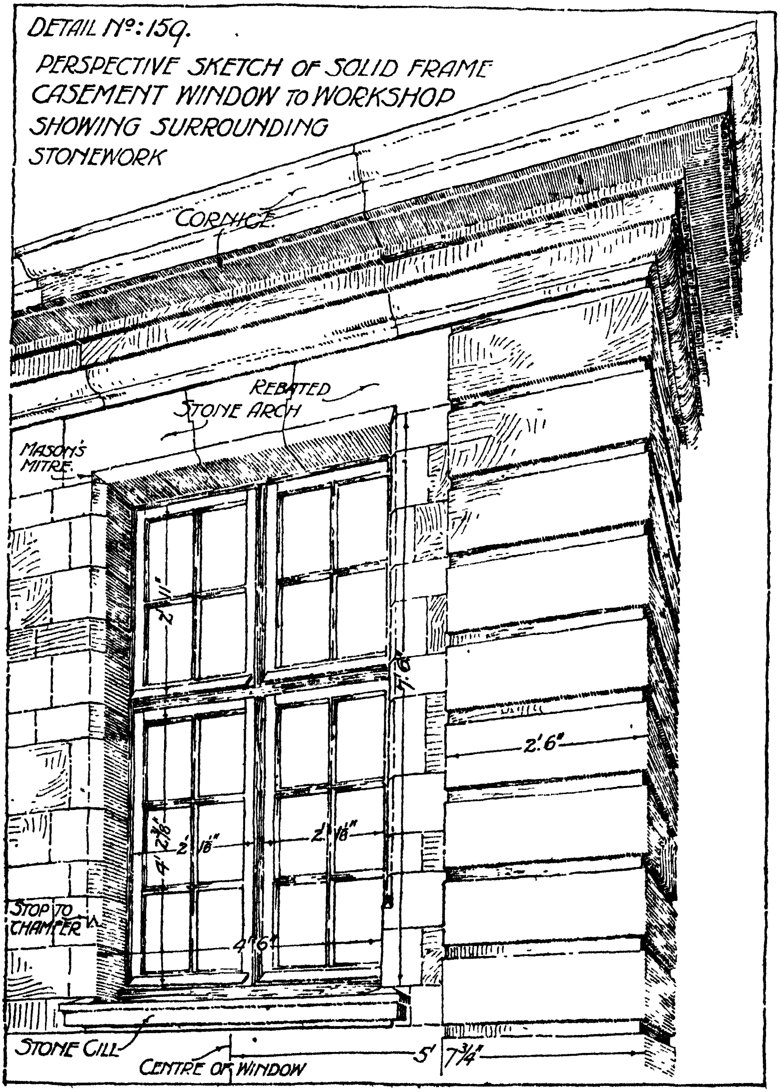
417. Provision for glazing. It should be observed that the ordinary mode of glazing is somewhat interfered with at the meeting rail of the bottom sash. Instead of a rebate for the glass to enter, a groove is substituted, because the other meeting rail is at the same level, obstructing the convenient use of a rebate.—See detail No. 157.

418. Fitting of sashes. Sliding sashes need accurate fitting; they must not be tight, neither rattle when closed. The bevel joint at the bottom rail of lower sash, and between meeting rails, enables a close fit to be obtained just as the sashes reach the point of closing; the angle of slope should be large enough to prevent jamming.

419. Weights. Sash balance weights are generally of cast iron, circular in section and $1\frac{1}{4}''$ to $1\frac{3}{4}''$ in diameter, slotted and holed for the cord as per detail No. 153. To "hang" the sashes, viz. attach the weight after fixing the frame, the cord is secured to the stile, passed over the pulley and the weight attached through the "pocket" previously referred to.

Workshop Windows

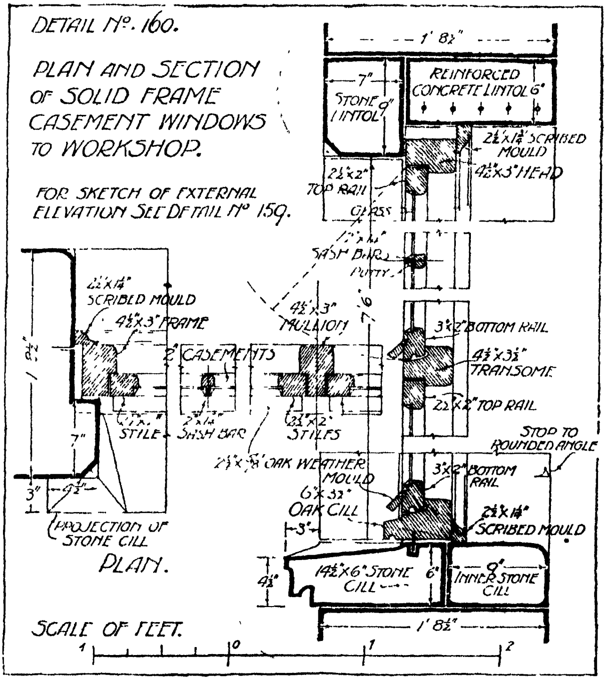
420. Casement frames and sashes. These often call for special treatment in order to serve for adequate ventilation of workrooms and are commonly of (*a*) the pivoted type, as shown in



detail No. 162, or (*b*) when the opening is large, a combination of casements.

In the first detail of proposed window, No. 159, is shown a "two light" frame with transome lights, viz. a division of the stone opening into two openings in width and two in height by a mullion and transome. (The mullion is the "vertical dividing piece" and the transome the "horizontal intermediate.")

The "lights" are arranged as 2″ sashes fitted into external rebates in the frame, enabling permanent fixing or outward



opening parts to be used as desired. It is unusual to make all lights to open, but such parts as are convenient for use may be made to open.

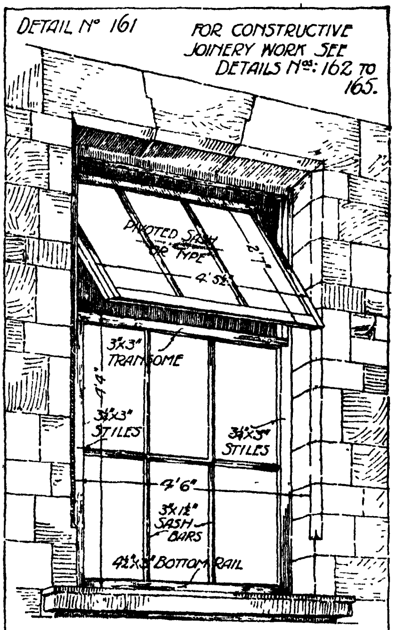
In order to maintain a uniform effect, the sashes (fixed or hung) should be identical in dimensions and finish to each opening.

The transome lights in these details are hinged on the top edge and open outwards, as illustrated in detail No. 160.

421. Construction. The construction of the frame is quite simple, the head ($4\frac{1}{2}'' \times 3''$) and oak cill ($6'' \times 3\frac{1}{2}''$) passing through

on the face with $4\frac{1}{2}'' \times 3''$ stiles cut between; the transome fits between the stiles and the mullion is placed in short lengths between the horizontal members. Transome and mullion are $4\frac{1}{2}'' \times 3''$, the former being "weathered" like a cill. Mortice and tenon joints are used throughout.

422. Standsheet sashes. For workshops, the above form of window, while good for ventilating purposes and very convenient, is expensive; an alternative window is shown in detail No. 161,



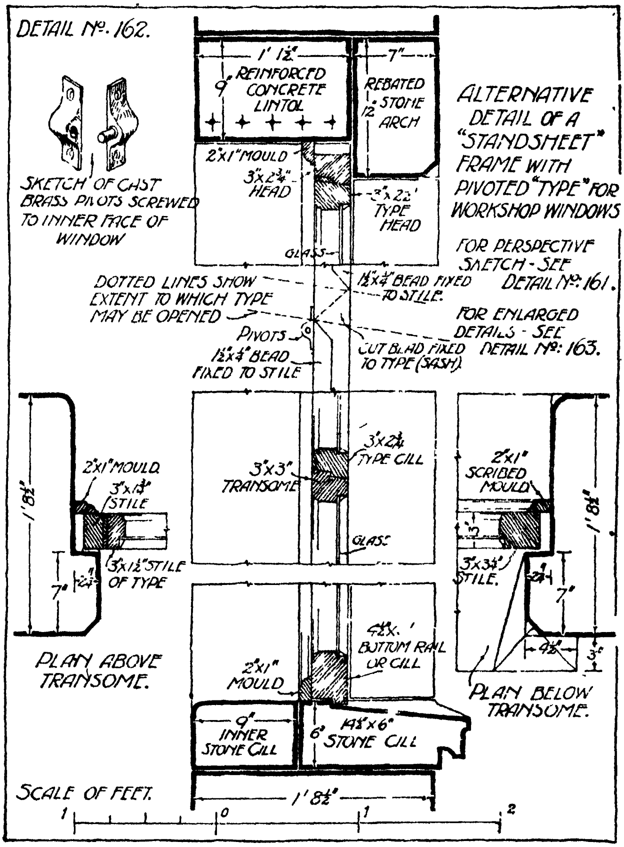
PERSPECTIVE SKETCH OF ALTERNATIVE "STANDSHEET" SASH WITH PIVOT HUNG "TYPE" FOR WORKSHOP WINDOWS.

which, with variable dispositions of the opening parts, is employed very largely in parts of the North of England for workshops and factories.

It is prepared in two forms (one of which is not illustrated). The simple form is a sash, 2" to 3" thick, fixed directly into the recess of the brickwork and receiving the glazing without any frame, and no part made to open. This is known as a "standsheet" sash.

423. Type sashes. Should a pivoted part be constructed to open in any section of the sash, with the whole framing maintaining a

uniform thickness, it is known as a "type" sash, the "type" being the opening portion. It is usual to pivot this as a centre hung sash with the sash centres screwed upon the inner faces of the flush frames. This form of the sash is fully illustrated in details Nos. 161 to 164.

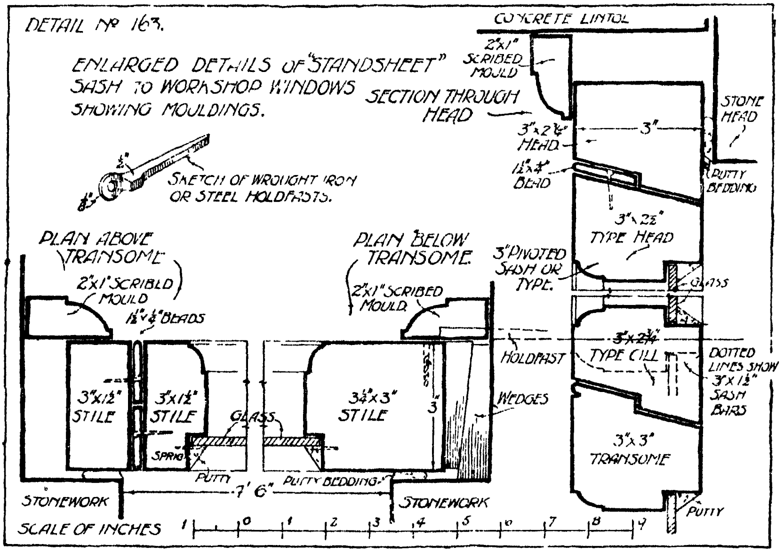


For window openings up to 5′ × 3′ these sashes are made 2″ thick, up to 6′ 6″ × 3′ 6″—2½″ thick and 3″ if of larger dimensions. (Small openings may, of course, have the stronger sashes if desired for better work.)

The mode of construction should be clear from the details and conforms with that of sashes generally. The only troublesome joint occurs between transome and stile, where the latter is reduced in width to allow the "type sash" to be *inset*, thus avoiding increase

in the width of material at this point. A square shouldered tenon is employed, abutting on the reduced part of the stile, while the under-edge of the rail is recessed to the depth of the moulding and the latter mitred to the stile mould, as illustrated in detail No. 164; an alternative method is to "scribe the stile" at the reduction to fit the lower edge of the rail.

To secure "weather tightness" of this pivoted sash is the chief trouble. In unimportant positions no serious attempt at this is made, the stiles being left with straight joints and the head and transome rails bevelled $\frac{1}{2}''$ in 2″ to form a stop and drain out driving rain. Rebates as "weather checks" are a necessity in good work and may be provided as shown in detail No. 163.



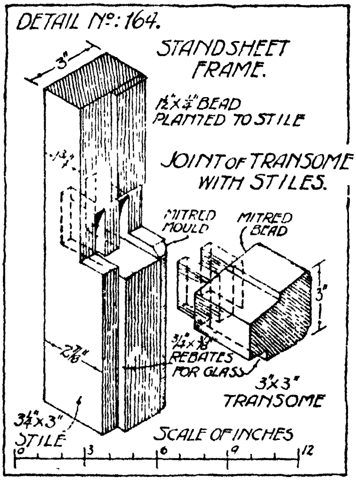
424. To determine centres and cuts. Positions of centres are first settled, say 1″ above the centre of gravity of sash and on the inside face. From these the sash is rotated until its thickness occupies the position shown by the dotted lines (see vertical section, detail No. 162) a little short horizontal. Lines showing thickness when open and when closed form a rhombus at their intersection; draw its short diagonal and place the "bead cuts" at 90° to this. The width of the beads are "half the thickness of the sash."

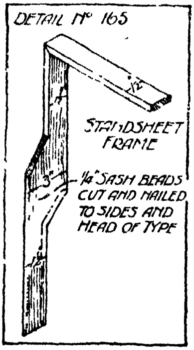
Sketch detail No. 165 shows how the portions of bead attached to the type are arranged.

When assembling the parts, beads are prepared and fitted, and painted along with the edges of the frame; when dry the surfaces

of contact are again painted in white lead and oil and the loose prepared beads, etc. bradded or screwed in position.

425. Cill joint. Special attention should be paid to the cill detail, No. 162, which shows a good arrangement for securing a weather-tight joint without a weather bar—known as a "rebated, sunk and weathered sash cill" or "bottom rail."





426. Fixing. These sash frames are usually secured by pairs of wooden wedges (see plan), and also by wrought iron or steel hold-fasts, detail No. 163, driven into the brickwork joints and screwed to the framing. Moulded margins, called "facings," are then mitred round the junction of frame and wall and neatly "scribed" to the latter.

Finishings to Windows

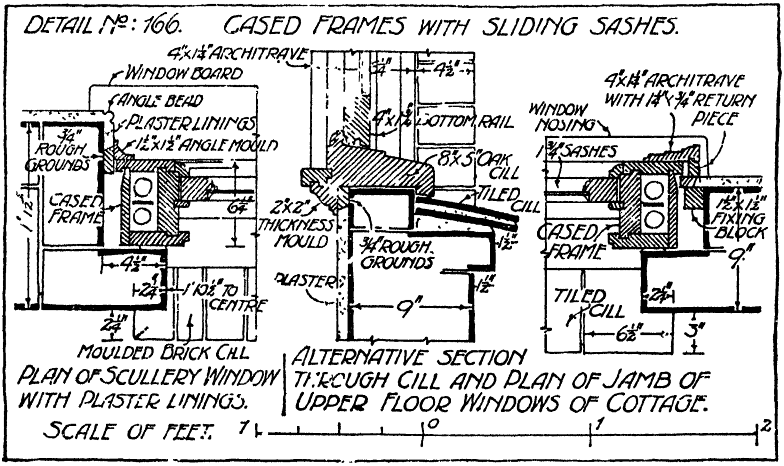
427. These are more or less similar to door finishings, viz. they provide the necessary cover to junctions of window frames with wall or plaster. They may consist of marginal moulds scribed closely to walls, as in detail No. 150, or have the surface plaster returned into the jamb and the joint covered by an angle mould, detail No. 166, or again, wooden linings may be tongued to the frame and faced by an architrave over the margin of the linings, grounds and plaster as in detail No. 153.

428. Window board. In all the window finishings (except those to the workshop) we have adopted the common method of covering the internal brickwork at the cill level with a window board (or bottom), 1" to 1¼" thick, projecting from the face of wall or plaster

a sufficient distance to receive the "architrave" or "marginal mould" to the opening. Its ends, therefore, must continue lengthwise past the vertical edges of the architrave to the same distance as in front, as shown in plan at details Nos. 153 and 166.

429. Thickness mould. Below the window board is a moulded member, called a "bed" or "thickness" mould, tongued to the board, as shown in detail No. 153, and providing support and finish to the projection. Its ends are returned at 90° to the wall, the ends of the window board and thickness mould agreeing in outline with the cross section of these members.

The thickness mould is laid upon a "rough ground" which is specially placed to receive it, and whose function has been previously



explained (see page 193). It should be framed at the angles to the vertical grounds. Wide and long window boards require cross bearers, 2″ × 1½″, laid between the wood cill and the above-mentioned ground and embedded in the brickwork, providing fixing for the window board by nailing at intermediate points; this prevents warping. Nails must be placed near the centre of these bearers, or in such a way as to allow freedom for expansion and contraction without splitting.

430. Window frames projecting within. In some cases a window projects past the plaster into the room, as in the double hung sash window of detail No. 166. The thickness mould in this case is placed against the wall and projects to the face of the architrave requiring a larger mould—2″ × 2″. For good design the faces of thickness mould and architrave should lie in the same vertical plane.

431. Workshop finishings. In connection with the workshop windows a different finish is adopted. Plastering is not required, therefore the inner reveals and cill of the windows are left exposed, bullnose bricks being employed to round off the sharp vertical angles, and a special inner stone cill serving in lieu of a window board.

The head of the opening is a reinforced concrete lintol finished neatly in cement mortar, 1 to 1, and left exposed.

At the junction of frame and jamb a scribed marginal mould is employed. Details No. 160 and 162 show the finish clearly.

Fittings and Furniture to Windows

432. We may now usefully study the metal fittings required for windows with sashes made to open.

All casements require ordinary butt hinges 2½″ to 4″ long and of stout steel plate, malleable iron or pressed brass; brass hinges with steel pins are preferable.

433. Fasteners and stays. If hung on the vertical edge the casement requires some means of securing from within when closed, and of "staying" when either fully or partially open. For securing a "one light" casement a "cockspur" fastener is commonly adopted, which consists of a short "lever" or "bar," mounted on a plate and rotating into a slotted plate fixed to the frame. The "bar" is actuated by a "lever handle" which is in a vertical position when the bar is horizontal and the window closed.—See detail No. 167.

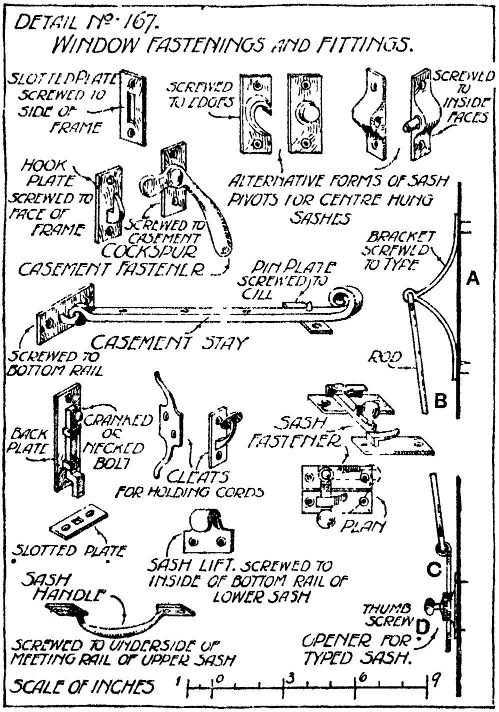
To stay the casement in various positions when open, a fitting termed a "casement stay" is employed as given in detail No. 167. It includes a long perforated plate loosely linked to a small plate secured horizontally in the sash. The perforations engage with a "pin" mounted on a plate secured to the cill. When closed, the "stay" lies parallel to the sash and upon the cill, the pin engaging with the last hole near the linked end. When open to the maximum extent it engages at the opposite end. The "range" of opening for such a stay depends on its length and the position when fixed.

434. Pivoted sashes. These require "centres," which consist of a pair of "pins mounted upon plates" and corresponding "socket plates" with which they engage.

There are two common types: (*a*) those designed to fix at the centre of thickness of a sash and fitted into the "edges" of sash and frame (see detail No. 167) allowing removal by withdrawing the sash and its pin mountings from the sockets along slots provided; (*b*) centres similar to detail No. 162, which are screwed to the faces

of sash and margin, and not directly removable. The latter are common in the North of England, and are usually of malleable iron.

Pivoted sashes may be secured by "cranked or necked bolts" fitted to the sashes near one or both vertical edges and shooting into plates housed into the beaded jambs of the frame (detail No. 167). To open and close the sash a strong metal eye is fixed to it, with a double cord attached serves the purpose, a Y cleat (in the



same detail) being screwed to the frame within reach for convenient attachment and allowing the desired range of opening. Several patent appliances are also available.

435. Top-hung casements are hung by butt hinges on their top edges and open outwards. They require some means of pushing the sash outwards and holding it there.

A similar form of stay is available to that described for casements, but, as a "straight stay" would incline upwards on opening, it is better formed to the curve traced by the sash at the point of attachment. A cranked bolt for securing when closed serves as in pivoted sashes.

436. Double-hung sashes. Besides the sash pulleys (which were specially described, along with cords and weights when dealing with the frame) the special fittings required are "sash fastener," sash handles and sash lifts.

The sash fastener provides a means of clasping the two sashes together at the meeting rails either by a "sash screw" fastener or a "pivoted" sash fastener. The former is very secure, though a little inconvenient; it allows the sashes to be drawn together at the meeting rails under all conditions, its effectiveness not being altered by expansion, contraction or warping of the material. Pivot fasteners, of heavy cast brass, are very convenient and quite effective when properly formed and accurately fixed; they are, however, affected by change in shape or size of material. Detail No. 167 shows a pivot sash fastener. A lever, pivoted to a recessed plate and held in position by a spring, is fixed to the outer meeting rail (top sash); when open it rests on this rail parallel to the sash and the two sashes may pass each other vertically. When closed it engages with a cast brass loop, so shaped that the small "lug" on the lever draws tightly against it as it moves outward across the joint.

In order to raise the lower sash, one or two "sash lifts" are screwed to the bottom rail on the inside of the latter. Their form is detailed in No. 167, which also shows a "sash handle," a pair of these would be required, fixed to the underside of the meeting rail of the top sash for use from the outside of the window. See application in detail No. 152.

437. Typed sashes, with the openings out of reach, are commonly opened by a double cord fixed to eyelets screwed into the right-hand stile near top and bottom; the cord is secured to a cleat as described for pivoted sashes.

Another good and simple fitting for *adjusting and securing* centre pivoted sashes of any kind is shown in side elevation at detail No. 167. A wrought iron bracket of $\frac{3}{8}''$ round bar, with flattened ends and an eyeletted centre, is fixed to the sash stile at A. It engages with a loosely linked straight rod B, which again is linked to a flat plate C, whose position remains vertical, moving in a slotted casting and gripped in any desired situation by a thumb screw D.

CHAPTER THIRTEEN

JOINERY—STAIRS

Terms Employed

438. *Staircase.* That portion or enclosure of the building in which the stair is constructed.

Stair. A series of steps enabling a person to ascend or descend from one floor level to another.

Step. A ledge on which the foot may be securely placed in the process of ascending and descending.

In wooden stairs a step usually consists of a horizontal board and a similar, but thinner, vertical board supporting its front edge. The former is called a "tread" and the latter a "riser" (see next clauses).

Tread. The part of the step on which the foot is placed; commonly 1″ to 1½″ thick, but may be thicker for special purposes.

Riser. The vertical portion of a step providing a support to the tread—a guard to close up the openings which occur between the treads. Generally of material ¾″ to 1″ thick.

Flight. One series of steps without any break in their direction, or change in size and shape.

Flier. A straight step having a parallel width of tread. *Winder,* a tapering step used at "turns" of the stair and often called a "turn tread." Does not occur in our examples.

Landing. Virtually a resting-place—also a means of providing a change in the direction of ascent or descent. Usually "marks also a definite level" forming one objective of ascent or descent.

String. An inclined board, 1¼″ to 2″ thick, providing support for the steps and into which the treads and risers are housed and wedged. A "wall" string stands against a wall; an "outer" string has one face completely open to view; a "close" string has top and bottom edges parallel.

Newel, or "newel post." A post placed at the head or foot of a stair, or at changes of direction, to receive and support ends of "strings" and "handrails."

Handrail. A rail parallel to the "rake" or inclination of the stair at a convenient height above the steps for rendering assistance in ascending or descending; in open stairs and at landings, it also forms a guard in conjunction with balusters.

Balusters. Light fillings between the handrail and string or handrail and floor; usually vertical members, either square or cylindrically turned to moulded forms.—See also "porch balusters," details Nos. 112 and 113.

Nosing. The projecting front edge of a tread.

Scotia. A thickness mould under the nosing, similar to the one used for a window board. May be a "cavetto" or any other suitable mould.—See details Nos. 169 and 170.

Carriage or *Bearer.* An inclined timber placed intermediately between the string boards to give further support to the steps.

Rough Brackets. 1″ × 7″ boards (or thereabouts) fixed to the sides of the carriages with the grain vertical. Each bracket supports a step directly under the tread and transmits any load to the carriage.

Apron Lining. A wrought board placed on the face of a joist or trimmer abutting on the staircase. Gives a finish to the surface and terminates the ceiling plaster.

COTTAGE STAIR

439. The stair to the cottage consists of a straight flight of steps required to provide a vertical ascent of 9′ 6″ within an available space of 10′ 6″ in length.

The "ascent" or "lift" is from ground to first floor, and the length of space taken up by the stair horizontally is called its "run." We may determine the run available by noting the required width of lobby at the stair "foot" and the necessary landing space at the stair "head."

Knowing the lift and run, we have now to determine what "rise" shall be given to each step and what "going" may be allowed. "Going" is the horizontal distance between the faces of adjacent risers. It is often called the tread. "Rise" is the height of a step.

440. Step proportions. The ratio between "going" and "rise" of a step in a well-proportioned stair must be such as to ensure easy ascent to the average person in reasonable health, and it has been established that a convenient means of guidance in selecting dimensions is provided by making "twice the rise added to the going" of a step to equal from 23″ to 24″.

Then it follows that our choice of a step is governed first by the number of steps we may get in the available length. Now one of the best steps in common use is 10″ going × 7″ rise, fulfilling the condition (2 × rise) + going = 24″. Use this step as a test and find whether we may use it in the available conditions.

Thus: available "run" is 10′ 6″ = 126″. Dividing this by 10″, we

get $12\frac{1}{2}$ steps, therefore try 13 and we have a "going" of $\frac{126}{13} = 9\frac{9}{13}''$ each. Now if 13 steps were used we should require 14 risers—one extra at the landing, being top of flight. Find, therefore, what rise is necessary to lift 9′ 6″ with 14 risers; $\frac{114}{14} = 8\frac{1}{7}''$ which is too much because $(2 \times 8\frac{1}{7}) + 9\frac{9}{13} = 25\frac{89}{91}''$ (say 26″). (You may, of course, check this approximately, *e.g.* $(8\frac{1}{8}'' \times 2) + 9\frac{3}{4} = 26''$.)

Reduce the "going" and get in more steps in order to reduce the rise. Try 14 treads and 15 risers.

$$\text{Run} = 126''. \quad \tfrac{126}{14} = 9'' \text{ going.}$$
$$\text{Lift} = 114''. \quad \tfrac{114}{15} = 7\tfrac{9}{15}'' \text{ rise.}$$

Then $(2 \times 7\frac{9}{15}) + 9'' = 24\frac{1}{5}''$, which is sufficiently near, because we do not desire any narrower tread unless unavoidable.

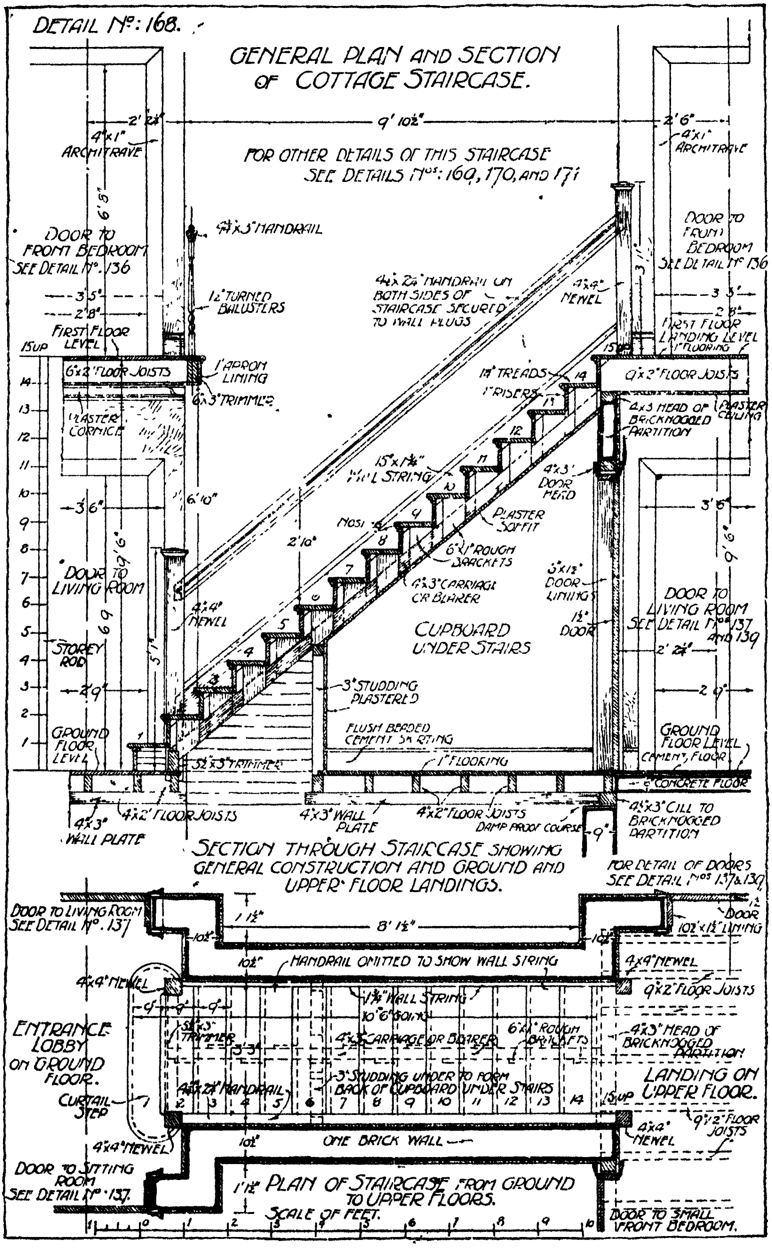
441. Setting out the stair. Examine the longitudinal section and plan of the stair and staircase in detail No. 168. In the section we see that the head (top end) of the stair must start at the partition wall between staircase and scullery and that 10′ 6″ from this wall brings the stair foot (lower end) as far forward into the lobby as may conveniently be allowed.—See general plan of cottage.

Set out the plan of the stair by dividing the available run into the required number of spaces (14); place a rule diagonally across the space between the containing lines so that any units, 14 in number, exactly fit between; point these divisions off accurately and drop verticals to represent the riser faces. Now erect a pair of vertical lines clear of the intended stair—see detail No. 168—and by a similar process set off the numbers of risers required. Accurate division is essential.

442. Storey rod. The vertical division here referred to is made in good practice on a wrought rod of pine, $2\frac{1}{2}''$ to 3″ wide × $\frac{3}{4}''$ thick, which is set up from floor to floor on the building marked and cut to the exact lift, tested and referenced before bringing away. When delivered to the workshop it is carefully divided into the number of risers in the stair, as per plan, and is used for measurement and reference in the detailed setting out. This rod is called a "storey rod" and is often shown as such on detail drawings.

In the drawing, having set up the storey rod and divided the run, step outlines may be projected directly from them and the detail filled in. Try to avoid repetition of operations in draughtsmanship by projecting as many similar points as possible at one operation.

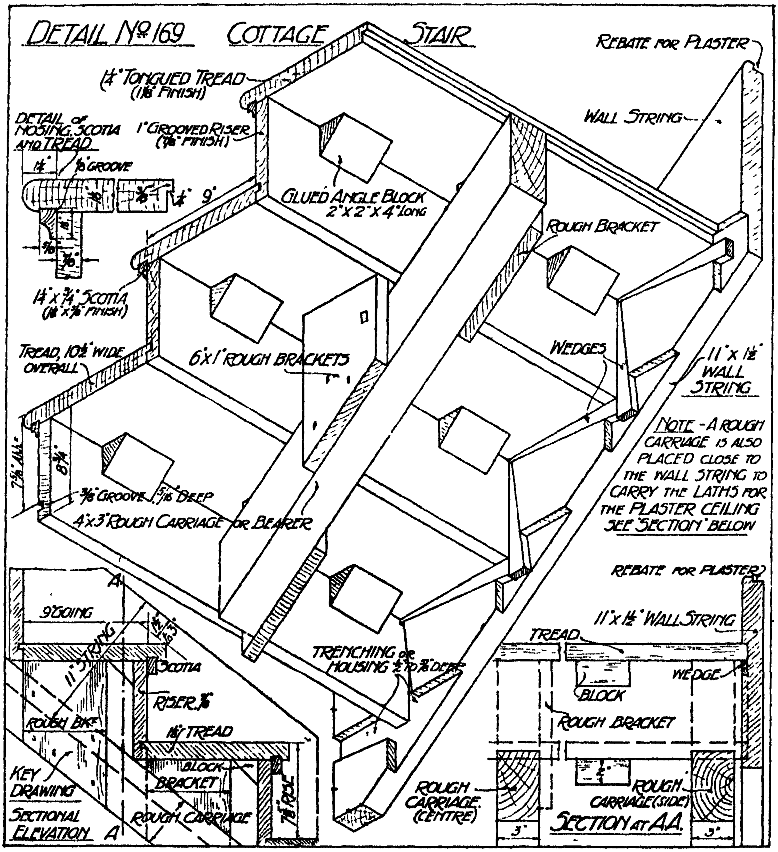
443. Width of stair. Before discussing the minute detail of construction, we should observe other general matters of interest. The width of a stair is important. Practical conditions cause it to vary from 2′ $7\frac{1}{2}''$ to 3′ 3″ in width when enclosed between walls; we advise a minimum of 3′ 0″ with a wall-handrail on one side and 3′ 3″ if a rail be provided on both sides.


DETAIL No: 168.
GENERAL PLAN AND SECTION OF COTTAGE STAIRCASE.
FOR OTHER DETAILS OF THIS STAIRCASE SEE DETAILS Nos: 169, 170, AND 171
SECTION THROUGH STAIRCASE SHOWING GENERAL CONSTRUCTION AND GROUND AND UPPER FLOOR LANDINGS.
PLAN OF STAIRCASE FROM GROUND TO UPPER FLOORS.
SCALE OF FEET.

444. Staircase and head room. Staircases should be easily approached, have good light and ventilation and height at every part to allow a person to walk erect.

A clear head space is required 6′ 6″ high measured vertically from a line drawn tangential to the nosings of the steps. This clearance is called "head room."

In important stairs 7 ft. clear head room is advisable.



445. Construction of stair. The stair consists of two wall strings, 11″ × 1½″, with 11″ × 1¼″ treads and 7¾″ × 1″ risers housed into them ½″ or ⅝″ at the ends, and wedged as in detail No. 169.

To give free access to wedges the "housings" or "trenchings" in the string are continued to the back edge, thus allowing close and successful wedging by avoiding obstruction in driving.

446. Deep strings. Strings are usually 11″ wide and it is only necessary to use deeper strings when very long flights of steps are to be supported in an open well. When between walls support can be obtained by nailing through the strings to wall plugs or grounds.

447. Step joints. By the most general method the steps are jointed as shown in the principal details Nos. 169, and 170 and 171 at A. At the nosing the scotia piece is housed and glued, and the edge of riser is also shot square, glued, rubbed close and blocked. In this way, pairs of treads and risers may be prepared from material wide enough for the purpose, and left for some months to season, until required.

When needed, the tongued joints are prepared, nosings and scotia worked and exact dimensions obtained simultaneously, after which the steps are assembled by placing between the strings, cramping down, testing for accuracy and fixing with glued wedges and blocks.

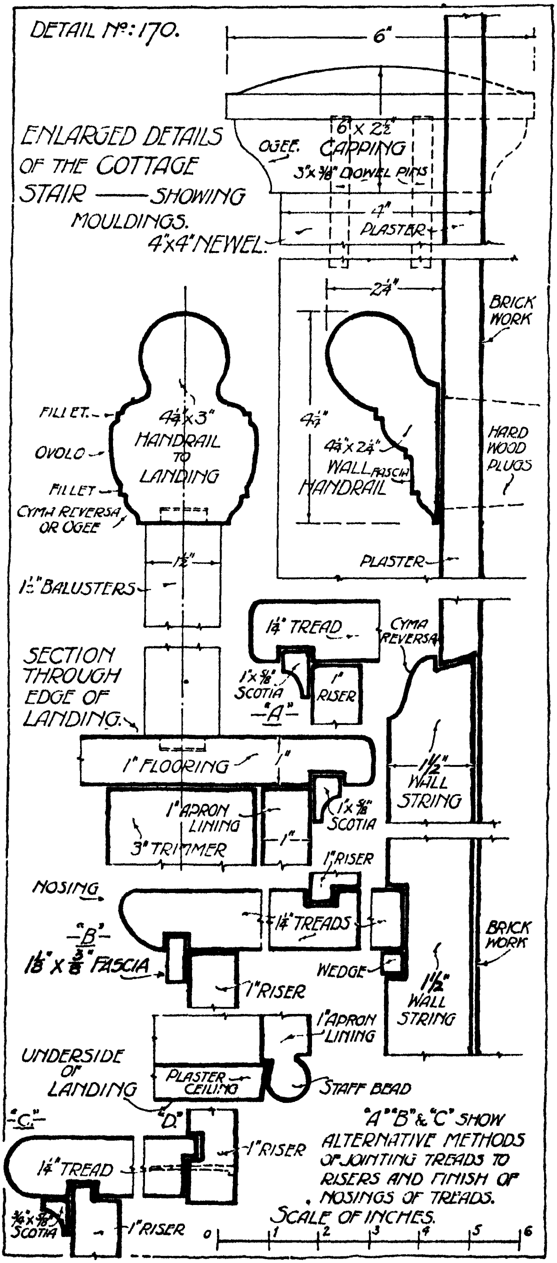
If to be placed between walls they may be nailed through the strings into the treads, otherwise they are blocked "tread to string."

448. North of England methods. In some parts of the North of England, the method of fitting together the parts of a stair differs considerably from the above, and causes different joints and alterations in detail.

It is common to assemble the parts by first placing top and bottom treads between the strings and nailing them after lightly wedging. The strings are then laid back edge uppermost and the intermediate treads slipped in from above, cramped horizontally and wedged, testing for squareness being conducted occasionally. Surplus tread wedges are next cut off, risers slipped behind the treads and wedged home.

The method requires that housings to receive treads and risers (including the allowance for reception of wedge) shall continue to the back edge, and also that the treads shall stop at (or near to) the riser face, in order to allow the riser to pass behind it. In good northern practice the nosing joint shown in detail No. 170 at C is usually employed, but considerable variation of choice may be exercised; the back edge joint is invariably tongued as at D. The tongue is $\frac{5}{16}$″ long and wedge room is sufficient to allow the riser to pass the tongue into position. The riser is at least 1″ thick, to avoid splitting by the tread bearing down upon it. If the treads are supported intermediately between the strings this danger is avoided and it is quite common in ordinary stairs to nail the riser to the back of the tread through a square joint. The scotia is skew nailed into the tread.

449. Choice of jointing. Both methods have advantages and disadvantages which may be summed up from the foregoing and both may be made good and satisfactory in capable hands. It is clear


DETAIL No: 170.
ENLARGED DETAILS OF THE COTTAGE STAIR —— SHOWING MOULDINGS.
6"
OGEE.
6" x 2½" CAPPING
3" x 3/8" DOWEL PINS
4"
PLASTER
4" x 4" NEWEL.
2¼"
BRICK WORK
FILLET.
OVOLO
FILLET
CYMA REVERSA OR OGEE
4¼" x 3" HANDRAIL TO LANDING
4¼"
4¼" x 2¼" WALL HANDRAIL
FASCIA
HARD WOOD PLUGS
PLASTER
1½"
1½" BALUSTERS
1¼" TREAD
CYMA REVERSA
1" x 5/8" SCOTIA
1" RISER
"A"
SECTION THROUGH EDGE OF LANDING.
1" FLOORING
1"
1½" WALL STRING
1" x 5/8" SCOTIA
1" APRON LINING
3" TRIMMER
1"
1" RISER
NOSING
1¼" TREADS
"B"
1 1/8" x 3/8" FASCIA
1" RISER
WEDGE
1½" WALL STRING
BRICK WORK
1" APRON LINING
UNDERSIDE OF LANDING
PLASTER CEILING
STAFF BEAD
"C"
"D"
1¼" TREAD
1" RISER
3/4" x 5/8" SCOTIA
1" RISER
"A" "B" & "C" SHOW ALTERNATIVE METHODS OF JOINTING TREADS TO RISERS AND FINISH OF NOSINGS OF TREADS.
SCALE OF INCHES.
0 1 2 3 4 5 6

that choice depends upon local constructive practice in assembling the parts of the stair.

450. Supports to treads. The stair is 15 risers in height, which is three or four risers more than one could recommend generally for an unbroken flight, but it would be both uneconomical and inconvenient to treat this plan otherwise. Because of the length of the stair, it needs good support from the strings, which are 11″ × 1½″, and are nailed to plugs in the staircase walls, through the string and below the treads. This fixing strengthens the whole structure.

A cross stud partition gives further assistance as shown in the vertical section of detail No. 168.

When a stair is 3 ft. wide, or over, the average size of tread requires intermediate support. We have adopted a 4″ × 3″ "rough carriage" or bearer, supported at head and foot by birdsmouth notching to the head of the partition and to a 5½″ × 3″ trimmer, respectively. The foot trimmer is laid on the floor between the bottom newel posts and tenoned thereto as shown in detail No. 168.

Rough 1″ brackets are pressed tightly against the treads, and firmly nailed to alternate sides of the carriage. If brackets are nailed to "one side," the carriage invariably twists and is not so effective. —See detail No. 169.

451. Newel joints. Strings are jointed to newel posts by oblique double tenons as shown at head and foot of string in detail No. 171. Tenons may be in the centre of thickness of the string, or on one side—barefaced; the former method draws the shoulders up more uniformly but cannot always be applied. A ½″ haunch is formed between the tenons to prevent warping and to close the joint.

The joint is drawn close by hardwood pins passed through the face of the newel, one to each tenon. The hole in the tenon is bored a little closer to the shoulder than the distance of the hole in the newel from its edge; a slightly pointed pin then draws the joint tight.

The upper newels may be further "stayed" and secured by bolting them to the sides of floor joists against which they bear.—See plan of landing, detail No. 168.

452. Handrails. Handrails might have been provided in this example by supporting them upon wrought iron brackets sufficiently clear of the walls, but it would cause a loss of space enough to restrict the rail to one side of the stair. Hence there are provided two wall-handrails of special design (detail No. 170), cut from 4¼″ × 2¼″ material, with a "roll" top edge and so shaped below as to be conveniently screwed to hardwood plugs in the wall.

To secure the ends of these handrails and to supply an acceptable architectural finish, newel posts are provided and the handrails are housed, tenoned and pinned thereto, as in detail No. 168.

453. Newel caps. Moulded caps are provided to the newels, with the grain horizontal, each being 6″ × 6″ × 2½″ thick and dowelled *to the post with four* ⅜″ × 3″ round hardwood pins.—See detail No. 170. If the design allows the post should be housed ⅜″ into the cap.

454. Bottom step. It was found necessary to allow the two bottom steps to stand within the entrance lobby, but to place the newels against the wall to gain space. Riser No. 1 stands 12″ beyond the inner edge of the newel. This arrangement calls for some special finish to the bottom step.

455. Bullnose step, etc. The most suitable treatment is to give a curved end to the step, such as a quarter round finishing against the front of the newel—called a "bullnose" step—or a semicircular end returning into the outside face of the newel—called a "curtail" or "round end" step, as illustrated in details Nos. 168 and 171.

456. Curtail step. Detail No. 171 shows how this is carried out in full, with a built-up riser block on which the circular shape is formed. Such a block is of well-seasoned pine (of small dimensions to ensure this) carefully prepared and well glued; when set it is shaped as if solid. The face covering to the curved block consists of a veneer cut down from the 1″ riser and continued round the end. The scotia is formed on a ¾″ board overhanging the riser block and moulded in continuation of the straight piece at the front.

The tread is of one piece with ends rounded in the solid and the back edges housed to notches in the newel; this counteracts effects of shrinkage and prevents open joints.

457. Plaster finish. Detail No. 170 shows the method of finishing the plaster upon the top edge of the string. The mould adopted is easily dusted, and the splayed rebate receives the plaster and allows for shrinkage. The stairs must be fixed before the plastering is done, which necessitates their protection by thin slabs of wood during the process.

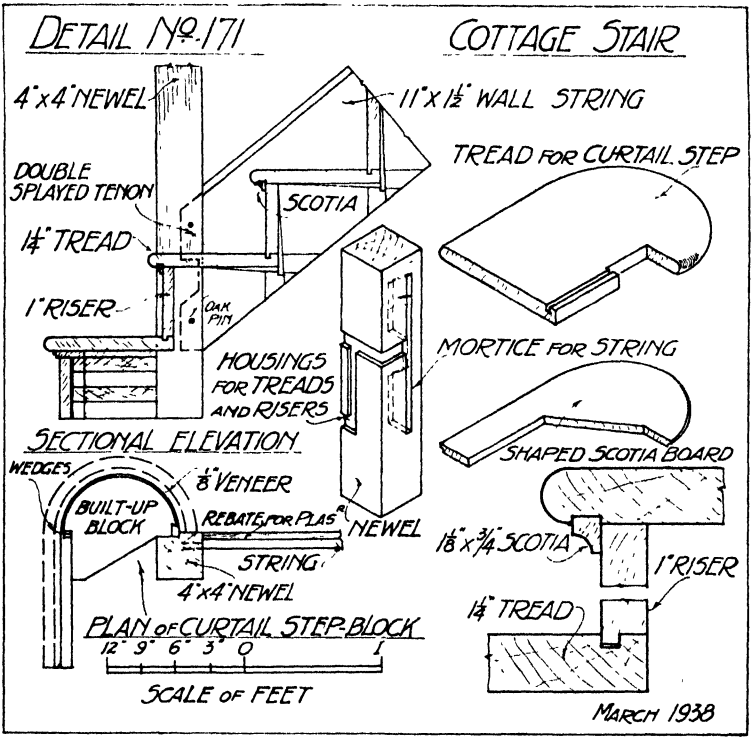
458. Passage over entrance lobby. A passage is provided above the entrance lobby, for communication between the bedrooms. It is left open to allow direct lighting to the head of the stair. The staircase is well ventilated by the window and door. The passage is guarded at the staircase by a handrail and balusters; the handrail, 4½″ × 3″, is moulded and morticed to receive 1½″ turned or square balusters which are stub tenoned to the floor boards, and the overhanging edge of the flooring is finished by a rounded nosing.

A 1″ apron lining covers the rough trimmer, and is finished at the lower edge by a "staff bead" (¾ circle) which accommodates the plaster and breaks the joint.—See detail No. 170.

459. Cupboard under stair. A storage cupboard is provided under the stair; its construction should be clear from the plan and vertical section, detail No. 168.

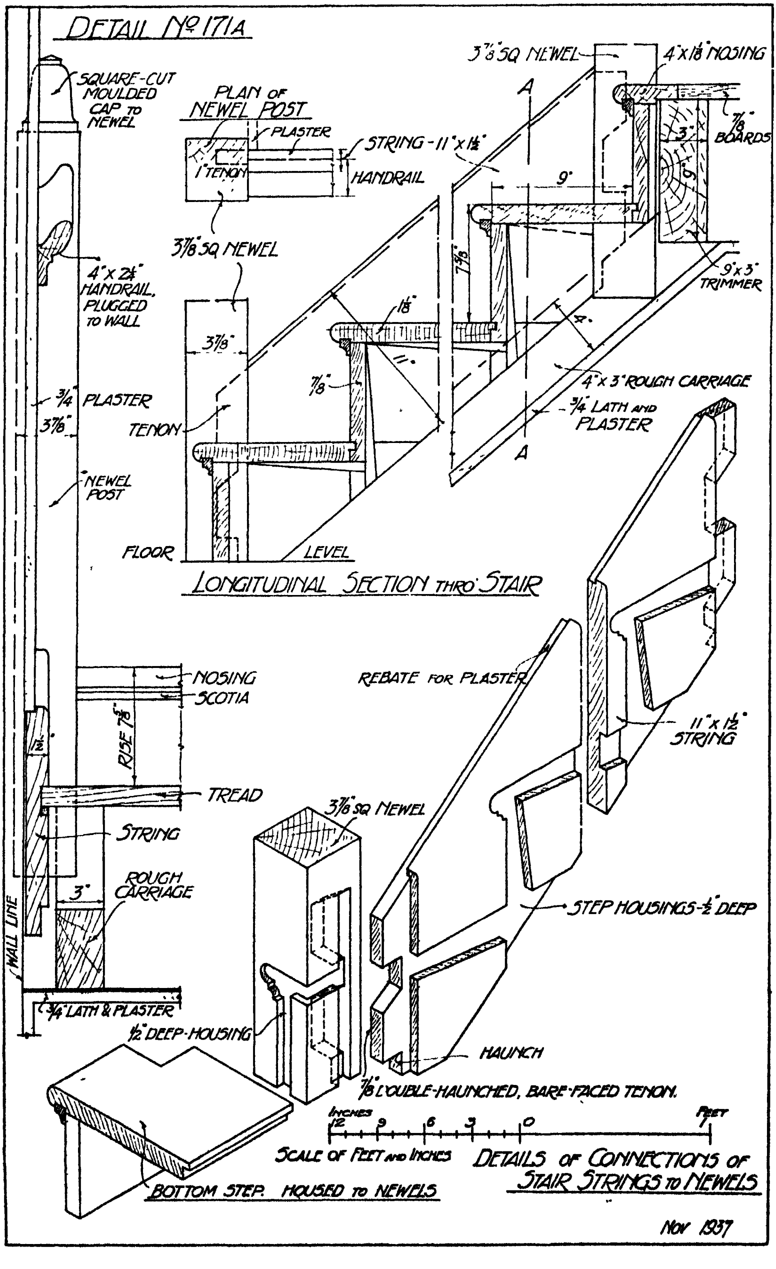
Flooring is carried as far as necessary and vertical studding forms a cross partition at 6′ 2″ from the bricknogged division.

The whole of the interior is plastered, the studding and the underside of the steps being lathed for the purpose.



The open space beneath the stair foot ensures ventilation of all the woodwork in the stair, and the latter is constructed to avoid draughts, while an air-grate in the back studding would ventilate the storage cupboard.

459 (*a*). The detail No. 171 A shows an alternative arrangement for the foot of a stair where no projection of the steps beyond the post is permissible. The newel post has a cap cut in the solid and a simpler wall handrail is shown. A section is also given of the edge of the landing showing the nosing finish and the upper newel post attached to the string.


DETAIL No 171A
SQUARE-CUT MOULDED CAP TO NEWEL
4" x 2¼" HANDRAIL, PLUGGED TO WALL
¾" PLASTER
3⅞"
NEWEL POST
PLAN OF NEWEL POST
PLASTER
1" TENON
STRING - 11" x 1½"
HANDRAIL
3⅞" SQ NEWEL
3⅞"
TENON
⅞"
1⅛"
11"
FLOOR LEVEL
LONGITUDINAL SECTION THRO' STAIR
3⅞" SQ NEWEL
4" x 1⅛" NOSING
⅞" BOARDS
3"
9"
9" x 3" TRIMMER
A
7⅝"
4"
4" x 3" ROUGH CARRIAGE
¾" LATH AND PLASTER
NOSING
SCOTIA
RISE 7⅝"
½"
TREAD
STRING
3"
ROUGH CARRIAGE
WALL LINE
¾" LATH & PLASTER
REBATE FOR PLASTER
11" x 1½" STRING
3⅞" SQ NEWEL
STEP HOUSINGS-½" DEEP
½" DEEP-HOUSING
HAUNCH
⅞" DOUBLE-HAUNCHED, BARE-FACED TENON.
INCHES 12 9 6 3 0 FEET 1
SCALE OF FEET AND INCHES
DETAILS OF CONNECTIONS OF STAIR STRINGS TO NEWELS
BOTTOM STEP HOUSED TO NEWELS
NOV 1937

CHAPTER FOURTEEN

JOINERY—MISCELLANEOUS DETAILS

Gates to "Works Yard"

460. Gates to entrances are of the nature of doors. They are, however, subject to all kinds of weather, and tend to speedier deterioration than internal work, or even of external doors, which are always somewhat shielded; thus, it is necessary to design and construct them with the object of getting rid of water quickly, in addition to maintaining their form and stability under these special conditions.

461. Type of gate. The gates to the workshop yard are of the "closed" type, *i.e.* they have the main portion of the area close boarded like a battened door.—See perspective sketch detail No. 172.

462. Framing. Each gate consists of a pair of $5\frac{1}{2}'' \times 2\frac{1}{2}''$ stiles, $7'' \times 2\frac{1}{2}''$ shaped top rail, $5\frac{1}{2}'' \times 2\frac{1}{2}''$ middle rail and $11'' \times 1\frac{1}{2}''$ bottom rail.

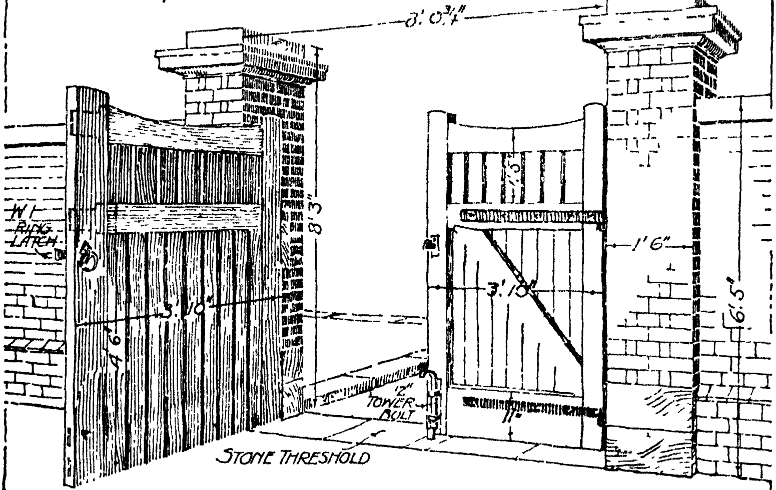
Braces $5\frac{1}{2}'' \times 1\frac{1}{2}''$ are also employed and the covered area is formed by 1″ matched boards tongued and grooved together, and similarly jointed at sides and head to the framing. In this case, the face boarding extends from the middle rail to the bottom of the gate, allowing a clear course for rain water; rails are also weathered or so shaped as to throw off water rapidly.

The upper panels are filled with $5'' \times 1''$ vertical boards having splayed edges and open joints; this form blocks the line of direct sight from the face of the gate, without restricting expansion and contraction of the filling.

463. Jointing. Jointing of the framing is largely identical with previous work; we should note the method of reducing tenon widths by haunching at each edge, when the rail is scarcely wide enough to necessitate the use of double tenons. Single, wide tenons, if employed here, would buckle when wedged. Double tenons (in width) may be used on 6″ stuff, but unwisely so on any narrower material.

All joints in gates should be secured by oak pins $\frac{1}{2}''$ diameter, as shown in detail No. 173, placed $\frac{3}{4}''$ clear of the shoulders.

DETAIL No: 172.

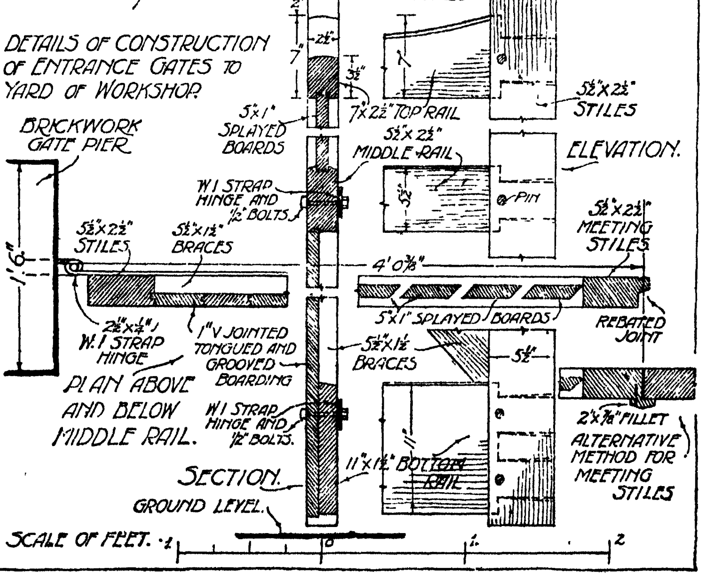


PERSPECTIVE SKETCH OF ENTRANCE GATES TO YARD OF WORKSHOP.

FOR MASONRY & BRICKWORK SEE DETAILS Nos: 2, 24, 36, 60, 64 AND 65.

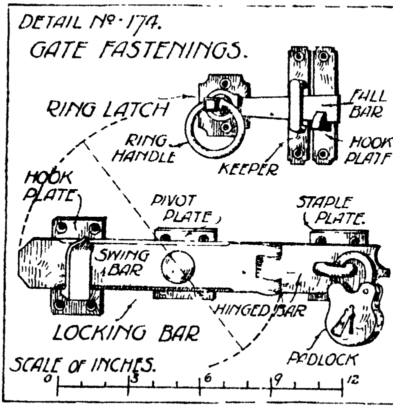
DETAIL No: 173.

DETAILS OF CONSTRUCTION OF ENTRANCE GATES TO YARD OF WORKSHOP.



464. Hanging. Heavy gates are suitably hung with long strap hinges, $2\frac{1}{2}'' \times \frac{1}{4}''$ by such length as will suit conditions, and secured with $\frac{1}{2}''$ screw bolts, through the centres of boards and rails. The straps have eyelet ends looped on to gudgeons which are walled into the gate piers along with the special hinge stones, as described and illustrated at detail No. 64. See also illustration at detail No. 146, and the description of somewhat similar hinges, as applied to heavy external doors.

In this case gates should be hung as closely to the piers as convenient, in order to reduce the opening at the jamb to the minimum. To close the gates at the centre, where they "fold" together, a rebated overlap is made—or a butt joint having a $2'' \times \frac{7}{8}''$ oak "coverslip." In the latter case the right-hand gate opens first, and some means must be adopted for securing the left-hand gate to receive its companion; this is done by fixing a heavy "tower" bolt or a "foot" bolt, detail No. 149, shooting into the threshold.



A ring-latch—similar to a Norfolk latch, but with a ring handle and rotary lift—secures the right-hand gate temporarily, while a hinged "locking bar" and padlock complete the means of permanently securing the gates. See illustration of these fittings in detail No. 174.

Skirtings

465. A "skirting" is a horizontal member placed at the floor level to cover the joint between the floor covering and wall plaster. It is also called a "plinth," being a base member, but we have chosen "skirting" as the distinguishing term for this particular use.

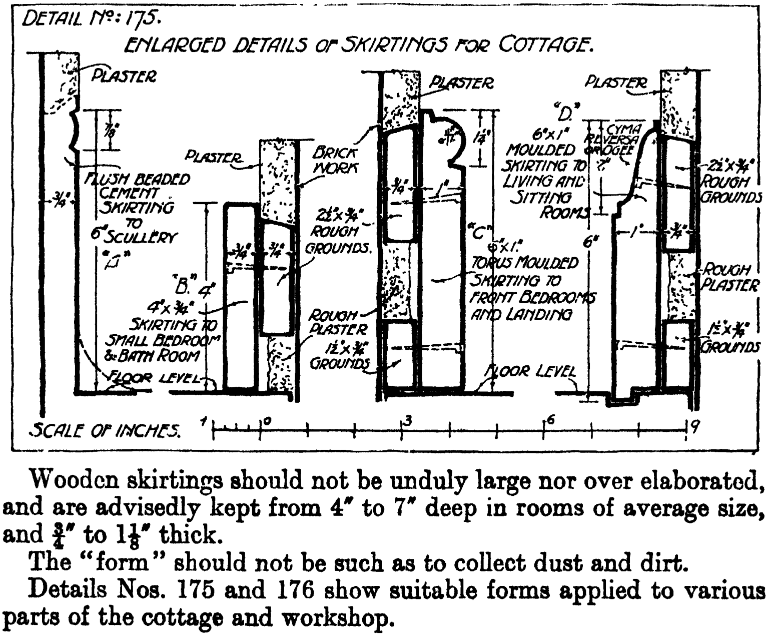
466. Plaster skirtings. These are correctly applied in portland cement plaster, to rooms with concrete or stone floors as in sculleries and basements, because they are not affected by contact with water to which they are liable during washing and cleansing operations. They are durable, damp resisting, not easily bruised or damaged, and take paint well where necessary. When applied above concrete floors it is easy to make the floor angle rounded and thus prevent the accumulation of dust.

The common forms are:

(*a*) A "flush" skirting with a sunk beaded top edge, shown at A in detail No. 175.

(*b*) A "projecting" skirting, ½" to ¾" in front of the plastered wall, and splayed on the top edge; not applied in our examples.

467. Wooden skirtings are in common use for living rooms, bedrooms, corridors and landings of a house, and for offices and entrances of workshops, etc. They can be wrought to a good finish, are generally free from accidental surface defects common to plain plaster skirtings and may be more decorative in appearance.



Wooden skirtings should not be unduly large nor over elaborated, and are advisedly kept from 4" to 7" deep in rooms of average size, and ¾" to 1⅛" thick.

The "form" should not be such as to collect dust and dirt.

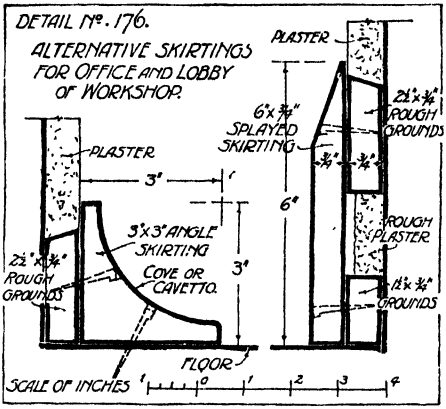
Details Nos. 175 and 176 show suitable forms applied to various parts of the cottage and workshop.

468. Cottage skirtings. For small bedroom and bathroom the skirting is 4" × ¾" with rounded top edge; for front bedroom and landing a 6" × 1" torus moulded skirting is used, and for living and sitting rooms the same size with moulded edge and tongued floor joint, shown at B, C and D respectively in detail No. 175.

469. Workshop skirtings. In the workshop a choice may be made between a 6" × ¾" deeply splayed wood (or cement) skirting and a 3" × 3" cavetto moulding.—Detail No. 176. The former is

suggested as being in harmony with the plinth to the glazed screen (not detailed).

470. General. In all cases wooden skirtings are liable to open at the joint between the floor covering and their bottom edges; hence they must be of dry, well seasoned material, scribed to fit the floor or, better, edge tongued to the flooring boards, as shown at D, detail No. 175 and in No. 177. A groove for this purpose is made in the flooring after it is laid, accurately drafted parallel to the intended plaster finish.



The greatest cause of the open joint occurring at floor and skirting is the shrinkage of deep timber joists which have been insufficiently seasoned and possibly settled a little at their wall plate bearings. Even when initially well seasoned, joists often become very wet during building operations in rainy weather. If sufficient time does not elapse between "closing in the building" and its "completion," subsequent shrinkage is great and the joists and flooring leave the skirting. A tongued joint (or some equivalent) between flooring and skirting is therefore the correct method for floors with deep joists and for all first class work. It also prevents draughts from behind skirtings caused by faulty brickwork joints.

471. Method of fixing. In common work wooden skirtings are fixed direct to plugs, placed in the vertical joints of the brickwork, alternately near top and bottom edges of the skirting. These are cut off to a plumbline, and to a line intended for plaster finish, in plan.

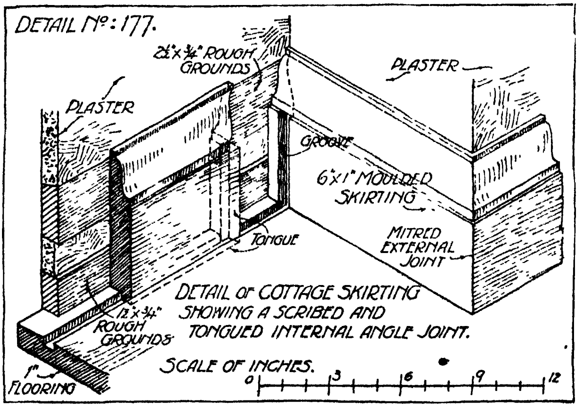
The whole wall surface is then plastered—except final coat—flush with the plugs. When the plaster backing is dry, the skirting is fixed, and the final coat flushed up to the joint.

This method of working is defective, because the woodwork finishings are present in a damp atmosphere, absorbing moisture; expansion and warping occur after the woodwork is fixed and force the parts out of place. After a time, as the atmosphere becomes drier, the wood begins to contract but it does not return to its original position; the forcible expansion against the nails and fixings has

strained it permanently, and the joints after contraction are permanently open.

472. Principle of securing woodwork. All fixed woodwork should, for this reason, be secured to rough grounds, and details Nos. 175, 176 and 177 show how these are placed. In shallow skirtings (up to 5″ deep) one $2\frac{1}{2}'' \times \frac{3}{4}''$ ground is placed $\frac{1}{2}''$ to $\frac{3}{8}''$ below the top edge of the skirting, and firmly secured to plugs at 2′ 6″ to 3′ centres. In deeper skirtings two rows of grounds are required, the top one $1\frac{1}{2}''$ to $2\frac{1}{2}''$ wide as before and a lower one $1\frac{1}{4}'' \times \frac{3}{4}''$ fixed close to the floor.

Space behind skirtings is filled with rough plaster to assist in avoiding draughts, prevent accumulation of dirt, and abolish harbourage for vermin.



Edges of grounds should be splayed, especially at the top edges, in order to provide an obtuse angle to the plaster, instead of a right angle, thus making the plaster less liable to leave the wall during the operation of spreading and trowelling; the skirting eventually covers the joints.

With a coved skirting (or angle mould) one ground only is required, close to the floor; it serves as a plasterer's guide and the coving is nailed on the splay into the floor and ground.—See detail No. 176.

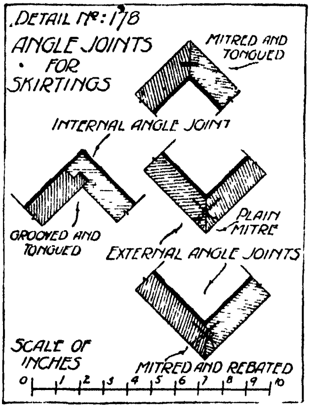
473. Joints. When two skirtings meet at a right angle, *e.g.* the corner of a room, or the external angle of a break such as occurs at a chimney breast, the method of jointing depends on the conditions and the quality of work desired.

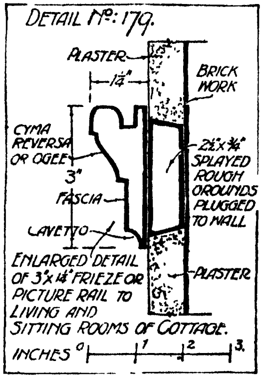
At an "internal" angle the end of one piece is commonly butted against the plastered wall and the end of the other "scribed" to fit it.

At an "external" angle a plain mitre is neatly cut and secured by bradding endwise from both external faces through the mitre.

Better methods are available and are shown in details Nos. 177 and 178. Consider the "internal" angle, detail No. 177. Its moulded margin is scribed as before stated but a groove is cut across the face of the continued piece, corresponding with a $\frac{1}{2}'' \times \frac{5}{16}''$ tongue on the end below the scribing, this tongue corresponding with the floor tongue on the bottom edge. This method ensures a vertical face to the entering piece and gives a "rigid angle," while allowing for slight disturbances caused by shrinkage.

474. Angle joints. Several angle joints are shown in horizontal section at detail No. 178, the mitred ones being suitable for external angles.





Their best application is for continuous edge joints lengthwise of the grain, but with care they may be employed at the skirting angle, by tongueing or rebating the plain portion only. The top moulded edge of external angles must *always* be plain mitred and in soft woods such joints are invariably nailed.

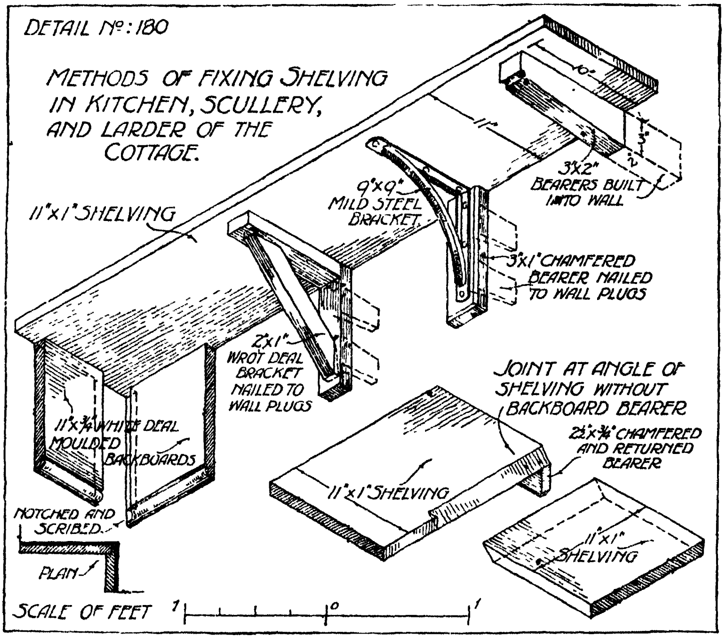
475. Cross tongues. The tongued joint is better suited to hard woods, tongues being formed by cutting them from broad material, having their grain lengthwise "across the joint"; these are known as "cross tongues" and should be glued in position, thereby dispensing with nails.

476. Picture rail. Detail No. 179 shows the profile section of a $3'' \times 1\frac{1}{4}''$ picture mould or rail and the method of securing it to the wall. It is applied in detail No. 137.

Shelving

477. Storage shelving, in common use for pantries and in kitchens and sculleries, usually consists of 1" × 9" to 11" white deal shelves, supported on some form of bracketted fitting. Alternative methods of preparing and fixing such shelving are given in detail No. 180.

(1) The simplest form of support is a 3" × 2" shaped and splayed "cantilever bearer," projecting 10" from the wall and built in (or housed and wedged) $4\frac{1}{2}$" or more, at distances apart not exceeding



4 ft. with a slight fall backwards to correct the sag which always occurs when the shelves are loaded.

(2) A second method is to construct a framed wooden bracket with a broad vertical back piece secured to the wall by nailing to plugs. The jointing of the frame is clearly shown in detail No. 180.

(3) Light steel brackets are available, made specially to supplant the heavy wooden ones; they may be fixed to a vertical wall piece secured to plugs as before.

(4) The best combination in the form of shelving is to construct an 11" × 1" shelf with an 11" × $\frac{3}{4}$" moulded "backboard" forming a frieze underneath it. On the backboard light steel brackets are screwed to support the shelf and keep the two at right angles. One

or more screws into the shelf give side rigidity to the bracket. This shelving may be prepared in lengths in the workshop, ready for fixing bodily as required upon prepared plugs or grounds. Short vertical grounds at 3 ft. centres serve well if the $\frac{3}{4}''$ backboard be firmly screwed to them.

478. Intersection of shelving. When two shelves meet at an angle they may be conveniently jointed as shown to the right of detail No. 180.

Intersecting backboards are also shown jointed at the left-hand corner of this detail.

Should backboards not be employed the shelf which passes through to the end wall is supported on a $2\frac{1}{2}'' \times \frac{3}{4}''$ bearer and the adjacent shelf "bevel housed" upon it, as in the above detail.

CHAPTER FIFTEEN

STANDARD STEEL AND IRON SECTIONS AND METAL FASTENINGS

479. It is convenient here to direct attention to the forms in which wrought iron and steel are manufactured for structural use, and to suggest that the student should attain facility in correctly drawing these sections before considering their more extended use in the next volume.

Bars of steel are obtainable in all the sectional forms shown in detail No. 181 A, while wrought iron bars are generally obtainable only in the simple rectangular and circular forms.

Flat and round bars and rods are produced by rolling hot metal into lengths of a constant cross section whose sizes may be anything between the limits marked on the detail; they are largely used in tension members for roof trusses, reinforcing bars for concrete, and for manufacture into screw-bolts, straps and plate connections to joints, all of these being suitably applied in either steel or wrought iron.

When "special shapes" are formed by similar rolling they are almost invariably of mild steel and are known as "rolled steel sections." The commoner of these sections consist of **I** or **I** form, **L** (angle), **T** (tee), and **⊔** (channel) shape, which are produced in a number of "standard" forms and sizes. **I** sections are commonly known as "rolled steel beams or joists," which is abbreviated to R.S.B.'s or R.S.J.'s. Detail No. 181 A shows some of these, and a table is attached giving the names and dimensions of their parts, the necessary angle between adjacent faces and the curvature of the angles in order to allow of satisfactory manufacture and practical use.

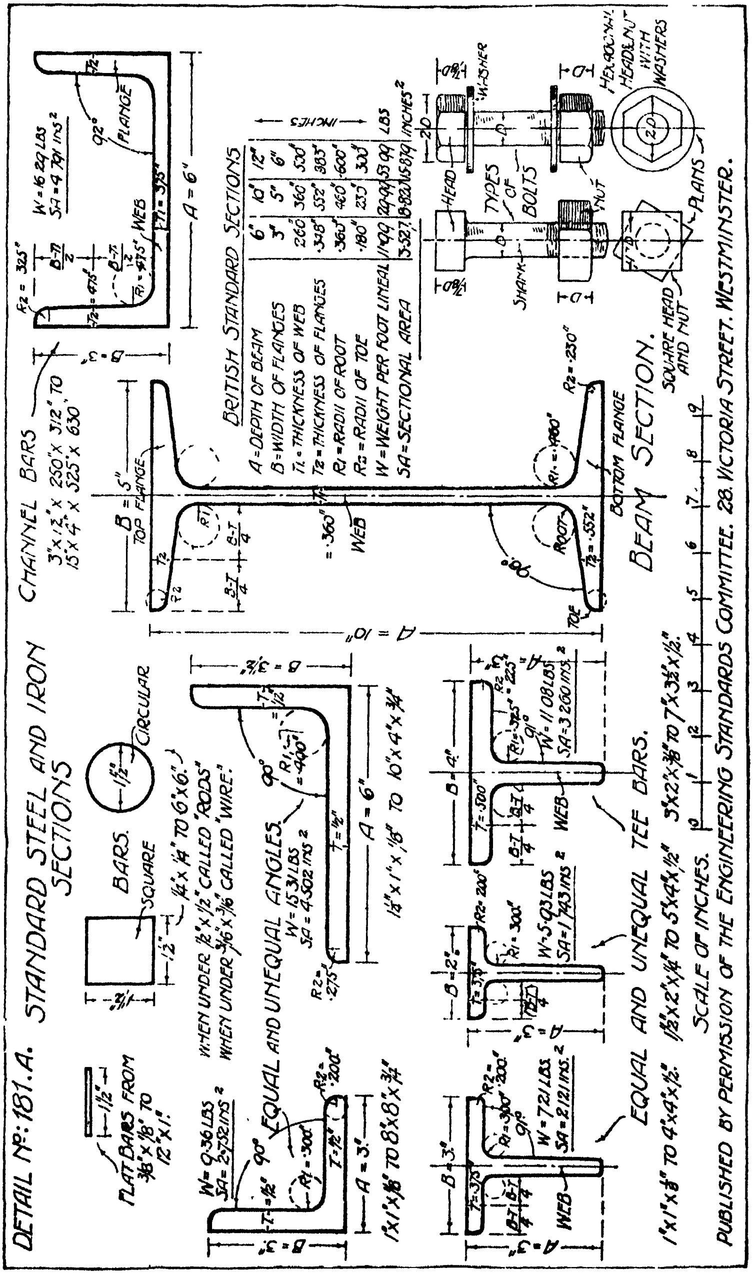
The sections illustrated might suitably be used in our two buildings as follows:

Flat bars, for stirrup and heel straps, three-way straps to wooden roof truss and also for head plate to composite truss.—See details Nos. 110 and 111. Also for camber bars.—Detail No. 49.

Circular rods and bars for reinforcing bars to concrete lintols (details Nos. 56, 160 and 162), king rod to composite roof truss (detail No. 111) and also for the numerous screw bolts required.

Tee bars (of small section) as alternatives in the reinforcement of concrete lintols.—Details Nos. 40 and 135.

I *and* **[** *sections*, might be used singly, or built up and employed as a front beam to carry the eaves of the shed roof of workshop, if found desirable to omit the brick pier in order to obtain an uninterrupted front.



BRITISH STANDARD SECTIONS

A = DEPTH OF BEAM	6"	10"	12"
B = WIDTH OF FLANGES	3"	5"	6"
T_1 = THICKNESS OF WEB	·260"	·360"	·500"
T_2 = THICKNESS OF FLANGES	·348"	·552"	·883"
R_1 = RADII OF ROOT	·360"	·460"	·600"
R_2 = RADII OF TOE	·180"	·235"	·300"
W = WEIGHT PER FOOT LINEAL	11·99	29·99	53·99 LBS
SA = SECTIONAL AREA	3·527	8·82	15·879 INCHES²

Nails, Screws and Bolts

In detail No. 181 B is shown a variety of nails, screws and bolts employed for fixing purposes in general building.

480. Nails are pieces of metal made to "drive" into position by blows from a hammer and are variously shaped to suit their special purpose. They may be employed to fix timber to timber, or to fix felt, slate, sheet lead or metal fittings to timber, and hence may require small heads to ensure neatness in the finished surface through which they are driven, or large heads either for security of fixing or to avoid penetration of the material to be secured.

Nails are made of cast iron, wrought iron or mild steel, though the former are almost obsolete except for some cheap slating nails and strong tile and slate pegs.

"Steel nails" are in most common use and include floor brads, clasp nails, round wire and oval wire nails.

Floor brads are cut from parallel plates, they have a taper in one direction only and a projection on one side to form a head. This allows them to be driven near the ends of boards without splitting, the point being a small rectangular surface which shears its way through the fibres. The wedge shape should act in the direction of the grain.—See detail No. 181 B.

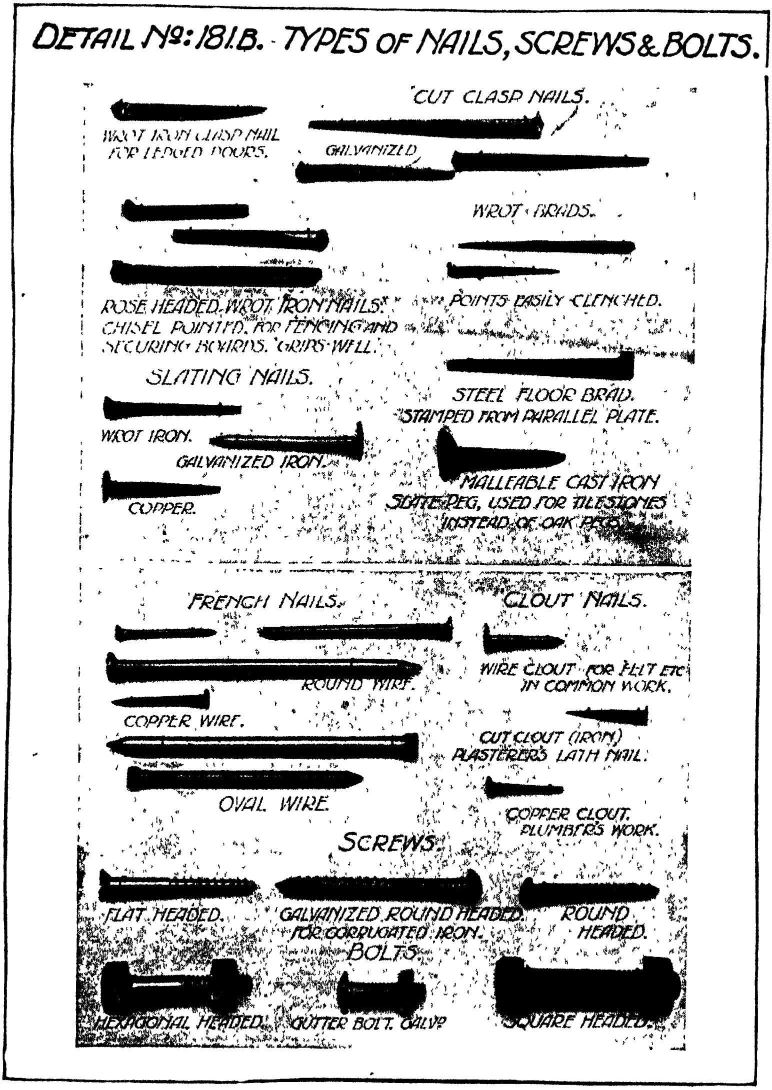
Cut clasp nails are used for general fixing, are tapered in width and thickness and have the head projecting a little on each side. These nails are being rapidly displaced by French wire nails.

French nails have parallel stems and are made of circular and oval section. "Round wire" nails are only employed by the builder in small or extra large sizes. The smaller are used for securing thin timber and the large sizes for carpentry work. "Oval wire" nails up to 3″ long are in most common use for all general fixing. They are less liable to cause splitting than other kinds and hold securely enough in soft woods.

Spikes. Large nails of any kind, when 5″ long or over, are termed "spikes," and round wire spikes are chiefly employed in securing carpentry work such as flooring and roofing timbers of the smaller sizes.

Wrought nails are made specially for clenching over at the points with ease, in order to secure them better against withdrawal in thin material. One form is particularly useful for fixing the battens to the ledges in ledged and similar doors and is provided with a sharp point, while another, having a chisel point and burred edges, is more suited for nailing fencing bars to strong posts and bearers.

Clout nails have very broad flat heads and are used for securing lead, felt, plasterers' laths, etc. They are obtainable in wrought metal, round wire or copper as shown in the illustration.


DETAIL No: 181.B. - TYPES OF NAILS, SCREWS & BOLTS.
CUT CLASP NAILS.
WROT IRON CLASP NAIL FOR LEDGED DOORS.
GALVANIZED
WROT BRADS.
ROSE HEADED WROT IRON NAILS.
CHISEL POINTED, FOR FENCING AND SECURING BOARDS. GRIPS WELL.
POINTS EASILY CLENCHED.
SLATING NAILS.
STEEL FLOOR BRAD.
STAMPED FROM PARALLEL PLATE.
WROT IRON.
GALVANIZED IRON.
MALLEABLE CAST IRON SLATE PEG, USED FOR TILESTONES INSTEAD OF OAK PEGS.
COPPER.
FRENCH NAILS.
CLOUT NAILS.
ROUND WIRE.
WIRE CLOUT FOR FELT ETC IN COMMON WORK.
COPPER WIRE.
CUT CLOUT (IRON) PLASTERER'S LATH NAIL.
OVAL WIRE.
COPPER CLOUT. PLUMBER'S WORK.
SCREWS.
FLAT HEADED.
GALVANIZED ROUND HEADED FOR CORRUGATED IRON.
ROUND HEADED.
BOLTS.
HEXAGONAL HEADED.
GUTTER BOLT. GALVD
SQUARE HEADED.

481. Screws provide a more secure method of fastening and yet allow of easy withdrawal when required. They are of circular section, slightly tapered and pointed and are threaded helically from the point with a thin band which occupies above half the length of the shank.

Screws are turned into position, passing loosely through the piece of material to be attached—gripping it by the head only—but allowed to cut their way into the backing piece along a hole bored slightly less in diameter.

The heads may be flat topped or hemi-spherical, the former being used where a flush surface is desired and the latter where projection is not objectionable as it provides a better grip due to the flat rim under the head.—See detail No. 181 B.

"Wood screws"—screws for turning into wood—may be obtained in steel, brass and copper, the steel ones being "japanned" when required to avoid oxidation.

Screws should be employed for attaching all furniture and fittings in joinery work and also for any purpose where subsequent removal may be desired.

482. Bolts and nuts. Bolts are screwed bars, generally of wrought iron or steel, having a parallel shank of any required length. They are used in conjunction with a "grip nut," for securing heavier pieces of work, such as strap hinges in joiners' work, built up lintols and roof truss joints in carpenters' work, and in their ordinary forms pass completely through the pieces to be connected.

They consist of a screwed rod having a solid forged head or "cup" (part spherical), square or hexagonal form and a square or hexagonal nut, which when turned into position enable a firm grip to be obtained upon the pieces of material, while allowing of easy detachment. The proportions of the various parts are illustrated in detail No. 181 A. "Washers" are square plates or circular discs of wrought iron or steel, $\frac{1}{12}''$ to $\frac{1}{4}''$ thick and up to 4″ diameter. These are placed between the metal head, or nut, and the timber surface on which the bolt may bear. Washers distribute the pressure over a greater area, and thereby reduce the intensity of pressure on the material.

CHAPTER SIXTEEN

ROOF COVERINGS AND FINISHINGS

Slating and Roof Plumbing

483. Roof coverings have been referred to in Chapter Nine, in relation to the framing provided for their support, and the angles of inclination stated which are suitable for coverings to the structures we are studying.—See page 130.

We have seen that the woodwork of the roof was completed either:

(*a*) By leaving common rafters ready for the wood slating or tiling laths to be fixed; or

(*b*) By boarding the surface ready for laying the slates directly upon it, or for intermediate treatment, such as "felting."

484. Workshop roof. Consider first the covering and finishings to the workshop roof. It is "slated," viz. covered with slabs of slate $\frac{1}{4}''$ to $\frac{3}{8}''$ thick and all of uniform size.

The sizes in most general use are:

Duchess	...	24″ long × 12″ broad
Countess	...	20″ ,, × 10″ ,,
Ladies	...	16″ ,, × 8″ ,,

and we have chosen the Countess size for our purpose.

In order to be clear in our references, you should note the following terms at once: when laid on the roof, the under surface of a slate is named its *bed*, the upper one its *back*, the bottom edge, *tail*, and the top edge, *head*.

485. Bonding. Slates are laid on principles of bonding which ensure that no edge joints occur "beneath" and "adjacent" to each other throughout the length of a slate and parallel to the slope. To accomplish this, what appears in section to be a "double overlap" is necessary. Examine the cross section at the edge of isometric detail No. 182; it shows that each slate is covered partially by *two* others and that the portion of any slate visible on the surface is somewhat less than half its area.

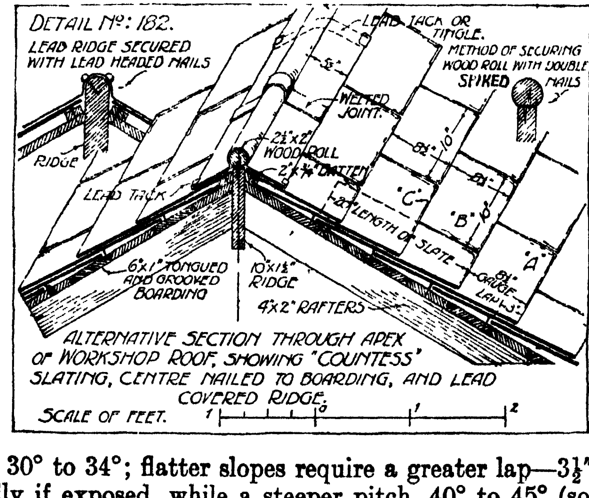
It is easy to see why this "double cover" is necessary. The edge of the course "C" is seen to overlap the course "A" by a length of 3″ clear and its joints are opposite those of "A" but centrally between those in course "B." Suppose "wind driven" rain, or snow, to fall on the exposed area of slate "B" close to the edge of a joint and be forced a few inches up the slope between the slates. It may pass

through the joints in course "B" and fall on the back of "A" without reaching the boarding.

Hence the actual "cover" of the courses is 3", and although at first sight the double overlap may appear wasteful and unnecessary it is really indispensable.

486. Terms in "laying." The amount of double cover is called the *lap*, and the exposed area of the slate its *margin*. On examination of the section, it will be seen that the "spacing of nails" used for fixing the slates agrees exactly with the length of the margin in dimension, but this spacing is referred to as the *gauge*.—See later.

487. Minimum lap. A minimum lap of 3" is found necessary, its actual value depending upon the "slope." The slope of a slated roof



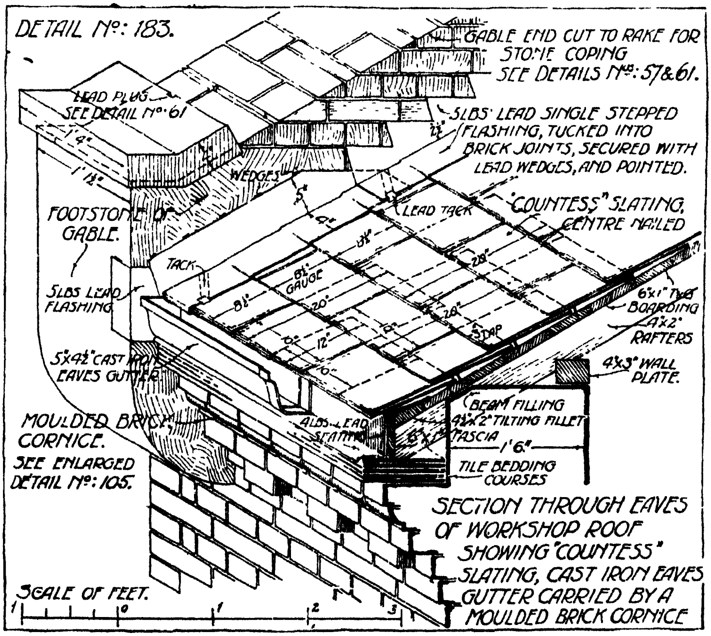
is from 30° to 34°; flatter slopes require a greater lap—3½" to 4"—especially if exposed, while a steeper pitch, 40° to 45° (sometimes used for other reasons), will serve with a 2½" lap.

488. Methods of fixing. Two methods of securing slates are adopted, known as "centre nailing" and "head nailing." The former is more general and is illustrated at details Nos. 182 and 183.

489. Centre nailed slates. Consider, in detail, the mode of nailing near the centre. Let a slate be 20" long and the lap 3" clear; because of the lap, the "length" of a slate less the "lap" is the length of two margins, and as the length of the "margin" and "gauge" are equal, we have gauge $= \frac{20-3}{2} = 8\frac{1}{2}''$.

To commence work at the foot of the slope, it is clear that we must get the lap immediately; the lowest course is therefore required to be 11½" long, or the length of the slate less the gauge, and the

first full course laid upon this with the side joints bonded. The lower course is called a "*doubling* eaves course," and is often provided by laying a course of 24″ × 12″ (Duchess) slates lengthwise of the eaves, taking care to break joint in plan, and cutting if necessary to obtain this. To enable the slates to bed closely upon each other it is necessary to lift the tail of the first course sufficiently to ensure the "tail" of the second course coming in contact. This is done by a "tilting fillet" (see detail No. 183) rising about 1″ above the laths or boarded surface. Tilt must be rather "over" than under size and *may* leave



the bottom courses slightly hollow, but the courses soon find their correct slope and the third or fourth course usually beds close.

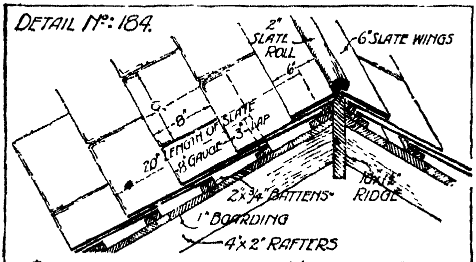
Observe the position of the nails used to secure the slates. The doubling course is nailed through holes punched 1″ to 1¼″ from the top edge and 1½″ or more from the side. All other courses are nailed "near the centre," viz. just clear of the head of the slate immediately below; the exact position of the holes from the tail of the slate is therefore *gauge* + *lap* + *clearance* above head of slate, and in this case would be 8½″ + 3″ + ½″, say 12″, from the tail.

It is now clear that the distance apart of the "lines of nails" will be the same as the length of the margin—it is called the "gauge," previously referred to.

490. Setting out. To set out this slating, decide size of slate (see para. 484), amount of lap and gauge; place a vertical line at overhang of slates at eaves gutter, as in detail No. 183, lay length of "doubling course" in position and full eaves course above it; space out the gauge up the slope and required laps beyond them. Then, length of any slate is twice the gauge + lap. Add sections of slates, successively working upon and above the boarding or lathing plane, and lastly show the nails (and laths, if any) in position; each lath would receive nails clear of the head of the slate bearing upon it.

491. Advantages of centre nailing. Slates are more rigid, and not easily lifted in a wind because leverage is short. There is a distinct economy of material, and repairs are more easily made.

492. Disadvantages. When the margin of a slate is broken the nail hole of the slate below is exposed and rain may enter upon the



SECTION THROUGH APEX OF WORKSHOP·ROOF SHOWING "COUNTESS" SLATING NAILED AT HEAD AND SLATE ROLL RIDGE.

boarding—or, if lathed and plastered below the rafters, may fall upon the ceiling.

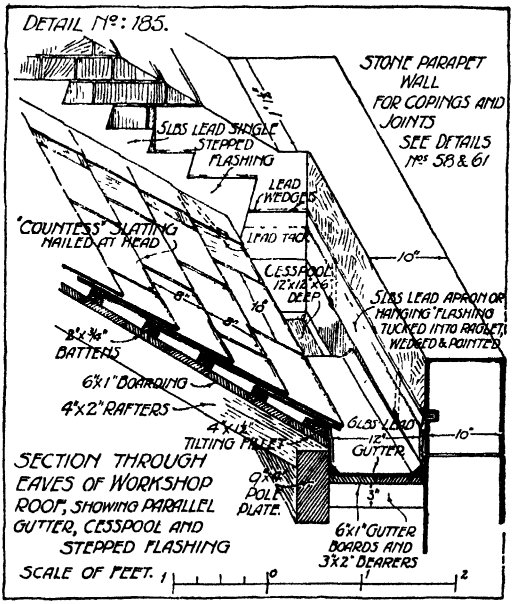
Slates may also be strained if nails are over driven, because they are hollow under the nails.

493. Head nailing. An alternative method of securing the slates is to nail them about 1″ from the head and $1\frac{1}{2}$″ to 2″ from the sides, exactly like the doubling course of the previous example and shown in details Nos. 184, 185 and 186. It is usual to consider the "lap" as the *clear double overlap below the nail holes*; there is good reason for this, because, although the holes are covered by two thicknesses of slate—instead of one as in centre nailing—the hole is in a more vulnerable position near the edge of the joint at the intermediate course, where the rain may drive in *when the slates are lifted in a wind.* The gauge in this case, with a 3″ clear lap, would be $\frac{\text{length} - (\text{lap} + 1'')}{2}$ and for Countess slates $= \frac{20-(3+1)}{2} = 8''$.

494. Advantages of head nailing. Nail holes are well covered in case margin of slate is broken, and the slate is not so easily strained in nailing.

495. Disadvantages of head nailing. Slates lift more in a wind and cause breakage near the head; snow and rain drift further up the roof between the coverings. Covers less surface than centre nailing having the same nett lap.

496. Methods of preparing roof surfaces for slating. The following methods of preparing a roof surface to receive slates are common; some are applicable to tiling.



(*a*) Slating battens only, 2″ × ¾″ or larger, nailed parallel to the eaves and at distances apart suited to the gauge required by the slating. Not illustrated here because more common to tiling and to cheap slating.

(*b*) Close boarding, with square or tongued edges, enabling nails to be driven anywhere and varied lengths of slates easily used in selected courses. Details Nos. 182 and 183.

(*c*) Close boarding and battens on the top. Battens support slates and receive nails. Details Nos. 184 and 185.

(*d*) Close boarding, felt and battens. Felt is laid on boards, and battens are placed horizontally as before. Detail No. 186.

497. Reasons for using the above methods.

(*a*) This method is economical, but requires the slates to be "pointed" or "torched" at the back joints and at the edges of laths and rafters, in order to prevent the entry of wind through the crevices, formed by irregularities in the bed and back of the slates in contact, or by variation in thickness.

(*b*) Secures the interior fairly well against draught if boards are well seasoned and joints are tongued and grooved, as shown at details Nos. 182 and 183; it is warmer than a batten hung roof.

(*c*) An air sheath is provided by lifting the slates above the boarding which renders the interior more equable in temperature and also assists in preventing decay by ventilation of timber.—See details Nos. 184 and 185.

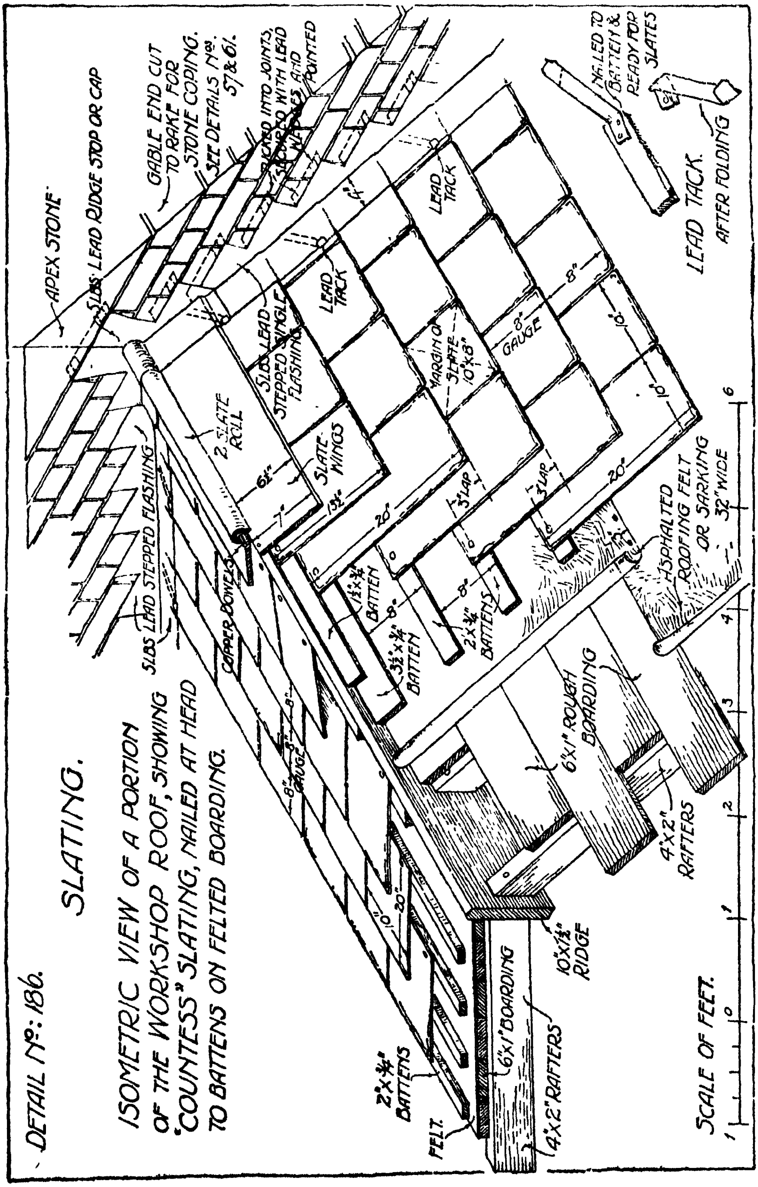
(*d*) Good, warm, reliable roof. Asphalted felt converts surface into a waterproof one, and if boards are dry when covered asphalte tends to preserve. Material is supplied in rolls, 32″ to 36″ wide, usually laid "across" slope, lapped 3″ at joints and close nailed with clout headed copper nails, but a better method is to lay the felt from eaves to ridge, as will be illustrated in a later volume. Felt should be laid out flat and exposed to the air for a few days in damp weather to prevent it expanding after laying, causing creasing and bulging. The only probable danger is of snow drifting occasionally between the slates and settling behind a batten, and the battens being nailed on through felt are vulnerable at nail holes here and there when the snow melts. Other roofs are subject to the same faults to a greater degree.

Nails used for slating and tiling are described at Chapter Fifteen.

498. Tilestones are thin slabs of stone $\frac{3}{4}''$ to 1″ thick made from an easily cleaved sandstone rock (cleft along its laminations) and used like ordinary slates but in irregular sizes. Being very heavy they require stronger roof timbers and are hung with oak pegs driven through the slate (with sufficient head thickness to grip) and hung behind strong battens. The weight of the covering is responsible for its security; either head or centre pegging may be adopted, the latter being more common[1].

499. Verges. Slating is finished at "verges" (gables) by making it overhang $1\frac{1}{2}''$ to 2″. A special slate $1\frac{1}{2}$ times the width of the ordinary slate should be cut to avoid the half strip which would otherwise occur in the bonding. No slate less than 5″ wide is reasonably allowable in any part of a roof. In order to secure the verge slating against being lifted, it is bedded solid in cement mortar upon the gable wall—which is neatly cut and built to the rake of the rafters —then the overhanging strip is "pointed" in cement mortar about

[1] Ordinary roof tiling is treated in Vol. II.


DETAIL Nº: 186.
SLATING.
ISOMETRIC VIEW OF A PORTION OF THE WORKSHOP ROOF, SHOWING "COUNTESS" SLATING, NAILED AT HEAD TO BATTENS ON FELTED BOARDING.
APEX STONE
5LBS. LEAD RIDGE STOP OR CAP
GABLE END CUT TO RAKE FOR STONE COPING. SEE DETAILS Nos. 57 & 61.
RACKED INTO JOINTS, SECURED WITH LEAD WEDGES AND POINTED
5LBS LEAD STEPPED FLASHING
5LBS LEAD STEPPED SINGLE FLASHING
2" SLATE ROLL
SLATE WINGS
LEAD TACK
LEAD TACK
MARGIN OF SLATE 10"x8"
8" GAUGE
3" LAP
3" LAP
COPPER DOWELS
1½"x¾" BATTEN
3½"x¾" BATTEN
2"x¾" BATTENS
ASPHALTED ROOFING FELT OR SARKING 32" WIDE
6"x1" ROUGH BOARDING
4"x2" RAFTERS
10"x1½" RIDGE
6"x1" BOARDING
4"x2" RAFTERS
2"x¾" BATTENS
FELT.
NAILED TO BATTEN & READY FOR SLATES
LEAD TACK.
AFTER FOLDING
SCALE OF FEET.

$1'' \times 1\frac{1}{2}''$ diagonally within the angle. This process is known as "collaring." The verge does not occur in our examples but could be applied to the back gable of the workshop if this abutted upon a street.

500. Eaves. We have previously seen the necessity for eaves gutters to carry away the water from the roof and that the slated eaves is projected partially over such gutter. Detail No. 183 shows the provision for this. A brick cornice is built at the top of the back wall to workshop, which carries the eaves gutter and forms a suitable finish at the eaves.

In the detail the brickwork of the cornice projects $7\frac{1}{2}''$ from the wall face, being finished with a heading course tailing $1\frac{1}{2}''$ into the wall. Above this is a series of tile courses $10\frac{1}{2}''$ wide laid in cement mortar. Their object is to form a seating for the gutter, with a means of easy adjustment to "falls" for clearing it promptly of rain water. The gutter must fall towards every down pipe from points centrally between them and "at least two" down pipes are required to the back elevation. Fall is obtained by increasing and diminishing the thickness of these courses, dispensing with tiles if necessary and adjusting the thickness of mortar joints by packing with slate, etc., invisibly inserted. The amount of fall should be at the "minimum" rate of $\frac{1}{2}''$ in 10 ft.

Observe that the necessary falls of the "tile packing course" are to be completed before the roof is fixed and the "eaves fascia," nailed to the common rafter ends, rests upon them.

501. Gutter bed. To prevent any leakage or overflow from the eaves gutter causing damp to penetrate the wall, the tile courses, fascia and tilting fillet are covered by a sheet of 4 or 5 lbs. lead, $15''$ wide, dressed $6''$ up the roof and overlapping the edge of the upper course of tiles.—See detail No. 183.

502. Parapet gutter. On the opposite side of the roof, a parapet gutter is constructed—hidden from view by the wall—having parallel sides, a falling base with "drips" for jointing the lengths of gutter base upon, and a "cesspool" at each end, the purpose of which is to collect and dispose of rain water.

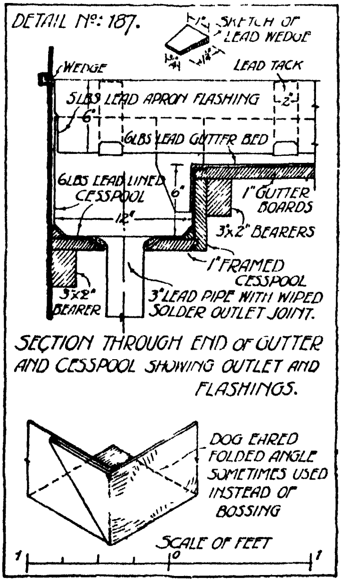
We have already seen how the woodwork of this gutter is constructed (see roof details Nos. 104 and 105). It is divided into lengths of 7 to 9 ft., made to fall at least $1''$ in 10 ft. and broken by drips $2''$ deep. (Where convenient, drips may be $2\frac{1}{2}''$ or even more.)

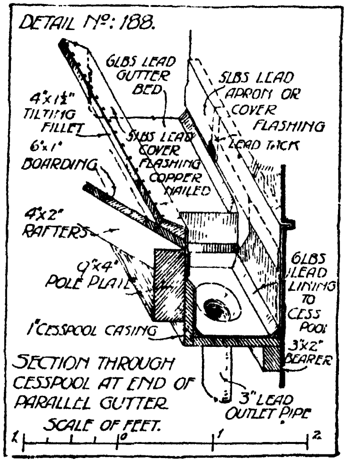
Before we describe the detail of construction relating to the lead covering of this gutter and its accessories, the student must realise the properties of lead and its usefulness for covering surfaces which

change frequently in direction. It is soft and malleable, will "bend," "draw," "shape" and yet with proper treatment maintain its form and position sufficiently well to form a reliable and durable covering.

In roof work, it is employed to make good against the weather all angles and intersections, and to cover irregular and doubly curved surfaces where some flexible material is demanded; it may also be most suitably employed on roofs of very flat pitch.

It is heavy, expands and contracts freely and if laid with its edges fixed, or on slopes of too great an inclination, buckles and bulges





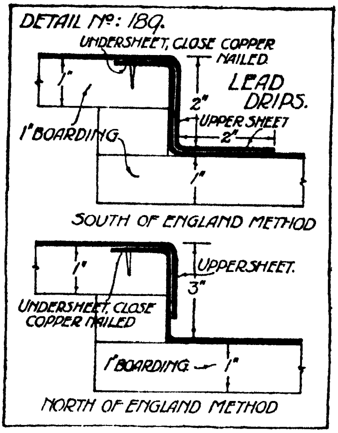
with continued expansion. It should only be fixed along two consecutive edges, being free to move bodily.

Follow the process of laying this parapet gutter in detail No. 185. It is commenced at the cesspool end; the cesspool is a rectangular depression, 6″ deep, with two wooden sides and supported as shown in details Nos. 187 and 188. The walls serve as remaining sides if in well faced material—otherwise a complete wood casing is preferable. A "dished" hole is provided in the base to receive the "outlet pipe," and triangular corner fillets are mitred round the base to clear away sharp angles.

The lining is formed by folding up a rectangular sheet of 6 lbs. lead, 29″ square, to the form illustrated at detail No. 187. This formation is known as "dog-eared" folding. In the detail of our

lining, the wall and roof sides stand up 10″ vertically, while the entry side is 7″ deep, 1″ of which is dressed flat into a rebate of the boarding, detail No. 187.

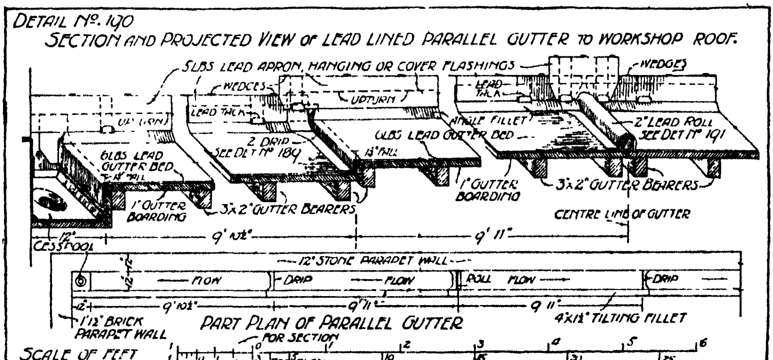
The length of the gutter is now lined in pieces reaching from "cesspool to drip," and "drip to drip," until the highest point of the gutter is reached. The first sheet lines the base and sides of the gutter to the full depth, overlaps the cesspool inlet $3\frac{1}{2}''$ to 4″ and is dressed against its sides with an upturn of 5″.



As each drip is reached the head of the lower sheet is recessed into the surface of the upper gutter board and the succeeding sheet of lead lapped over it, down the drip, and 2″ or 3″ along the lower level.—See details Nos. 189 and 190. This double bend makes a more rigid angle to resist the lifting action of the wind.

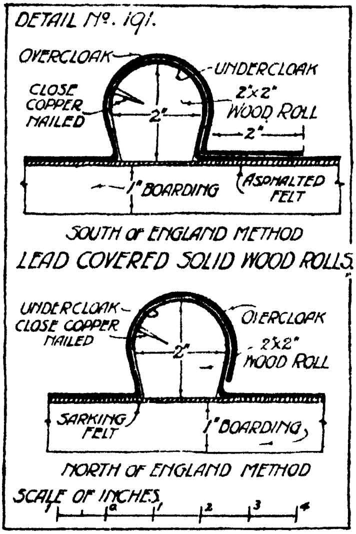
Note. In the North of England the commoner practice is to leave the overlap short of the lower level, terminating at 1″ clear thereof, in order to resist better the probable attraction of moisture between the sheets, from any local depressions in the covering near the joint. This is illustrated in the same detail. A 3″ drip is required for satisfactory work in this case. Other methods are available to resist "capillary attraction."—See later volume, and also Manson's *Experimental Building Science*, Vol. I.

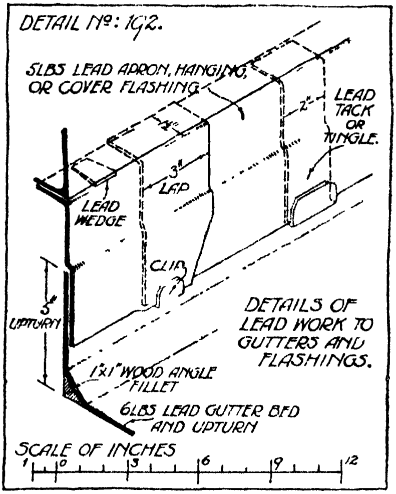
At the highest point of a gutter, if falling both ways, a 2″ wooden "dressing or saddle roll" is laid across the gutter, as shown in detail



No. 190, over which the edges of adjacent sheets are jointed. Its cross section, showing the "lap" and "grip" obtained, is given in detail No. 191, which also gives the names for the laps at the roll.

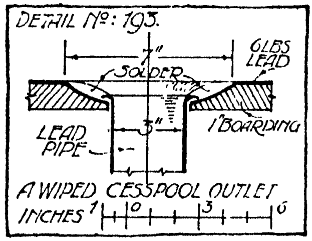
503. Cover flashings. We next require some form of cover to guard the turned up edges of the gutter bottom; 5 lbs. lead is used, 5″ or 6″ wide, tucked into a groove—called a "raglet"—cut in the stonework. This "cover flashing" is secured with "lead wedges" at suitable intervals and afterwards pointed with "oil mastic," or "portland cement." Details Nos. 186, 187, 190 and 192 show the application of these lead wedges.





"Cover flashings" (also called "apron" or "hanging" flashings) are in lengths convenient for handling, lapped 4″ at longitudinal joints and dressed close to the under sheet.

504. Cesspool outlet. Detail No. 193 shows the method of connecting the waste pipe to the cesspool base. The lead "lining" having been dressed into the hollow recess previously mentioned, the pipe is passed through, the rim expanded by a tampin, turned down slightly so that it grips the base and supports itself, and the joint is then "wiped" by filling with molten solder and finishing to a curved section at the cesspool bottom. Sufficient surface is required for "soldered contact," which will produce a rigid, well supported joint. The application of this joint is shown in details Nos. 187 and 188.



505. Gables. At the intersection of a roof and gable, or parapet, such as occurs in brickwork at the rear of the workshop (details

Nos. 183, 185 and 186), leadwork is again necessary to render the joint watertight. We have shown the commonest method, viz. a "stepped" angle flashing, formed from a sheet of 5 lbs. lead, about 4 ft. long and 9″ to 10″ wide, bent 4″ along the slate surfaces at the junction, and 4″ or 5″ up the wall. Its top edge is cut to the outline of the brick courses, being stepped up when the horizontal edge is within 2½″ from the slates. These steps are cut back at 90° to the slope of the roof, the horizontal edges tucked into raked joints in the brickwork, then wedged tight and pointed. By cutting the steps at 90° to the slope, the consecutive horizontal edges overlap each other and there is less danger of rain entering the space between them.

506. Tacks or clips. To prevent flashings being lifted by the wind, strong strips of lead (7 or 8 lbs.), 2″ wide and of such length as may be necessary, are employed as "tacks" or "clips" to clasp the edge of the lead in the fashion shown in details Nos. 183, 185 and 186. The tacks are clout nailed to the boards or battens close to the wall before the slates are laid, and turned against the wall as per sketch in detail No. 186. After slating, the tack is turned flat upon the slates, the flashing laid, and the projecting end of the tack dressed over the sheet and trimmed to size. A larger detail is given at No. 192 showing the tack applied to a cover flashing.

Soft copper tacks are stiffer and better than lead; while serving the purpose more efficiently they are more costly.

507. Ridge coverings and stops. Ridges may be covered in several ways to connect and cover the exposed top edges of the slates on each slope. Notice first, that in any case the slates terminate with a "double course," and the necessary "double overlap" common to all slating is obtained by the "ridge covering" referred to.

In order that both courses of slates may be nailed at the ridge, the under layer is stopped 2″ short of the "ridge piece" and nailed in position, then a second batten, fixed on the top of the roof boarding (detail No. 182) or above a "specially wide slate batten" (detail No. 184), is utilised to nail the upper course.

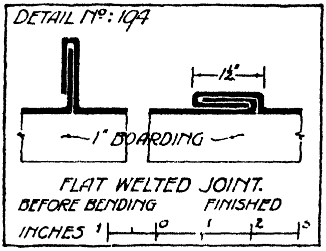
508. Slate ridge. One method of covering the ridge is illustrated at detail No. 186, where special pieces of slate, ½″ to ¾″ thick, one plain and the other with a 2″ roll edge rebated beneath to receive the plain piece, are secured as shown in section at detail No. 184. The plain slabs are screwed to the bevelled ridge piece and the joints broken *at least* 2″ with the slate joints below them, in addition to breaking joint at the two halves of the ridge covering. By the method shown, the slate roll rebates well over the head of its fellow—covering the screws—and if the whole be soundly bedded in mortar and pointed at the joints in portland cement, a durable finish is obtained.

An alternative arrangement is to lay the slate ridge with the

"heading joints" in one line, reverse the pieces (roll and slab) for alternate lengths, and to place a 6″ wide piece of lead under each joint, which while out of sight protects it against leakage. If the roll ends be "dowelled" in addition, it is practically impossible for the ridge covering to be shifted by wind.

509. Lead-covered ridge. An alternative method of ridge covering is to fix a 2½″ × 2″ wooden roll on the ridge piece by "double-ended" iron spikes, as in detail No. 182 (or by ordinary wire nails), between which lead or copper tacks are clasped, at 1′ 9″ to 2′ centres. A sheet of 5 lbs. lead is then dressed over the roll, wide enough to extend down each slope and past the head of the lower course of slates by an amount "at least equal to the slating lap." The tacks are long enough to clasp 1¼″ over the edges, stiffening and holding them against lifting tendency in high winds.

At junctions between the lengths of lead sheet, a plain overlap of 4″ or 5″ may be given, with a tack at the centre of the joint, or better a "welted" joint, 2″ finished length, may be formed by folding the ends of the sheets as in the section at detail No. 194 and dressing the fold close to the roll and slates, as illustrated in detail No. 182. It is very strong, and not easily disturbed. A more economical though less satisfactory method is to fix the lead covering by "lead headed" nails to a round headed ridge. This is shown in detail No. 182 on the left.



510. Ridge and gable stop. When the ridge roll, whether of "slate" or "lead covered," intersects a vertical surface at a gable, parapet, etc., as in detail No. 186, the junction needs weather proofing and the stepped flashings on each side connected or bridged over. The stepped flashings should be carried to a point about 6″ from the ridge, then a large "stop" or "cap" of 6 lbs. lead is dressed over the roll, down each slope and vertically against the wall, with an overlap of 3″ past the end of the stepped flashing. A tack is required close to the joint clasping both pieces of lead, and the stepped top edge of the flashing is made to agree with the similar work on the slope.

511. Leadwork at gable foot. The finish of the leadwork at the stepped flashing on reaching the foot of the roof slope is decided by the nature of the surface into which it is to be turned. Examine detail No. 183 carefully. Observe that the flashing higher up the slope is stepped, because the joints are convenient for receiving the horizontal "tucking" without specially cutting a groove. In good stonework (particularly ashlar) it is more convenient to let the

flashing run at the slope of the roof, and cut a raglet to receive the lead edge, as shown along the footstone.

At the upper end it is turned horizontally, to finish in keeping with the stepped flashing above it, and to avoid cutting into the sharp angle of the stone. Note here also, how the lead backing (gutter bed) to the eaves gutter is turned against the back of the footstone and carried 3″ round its end, where it is tucked into a raglet, wedged and pointed.

An alternative method is to carry the flashing across the footstone in horizontal steps in continuation of the stepped flashing to the brickwork. This is applied in detail No. 185 and is suitable for a short overlap on the footstone.

512. Provision for expansion and contraction. Before leaving the present consideration of leadwork, it is wise to notice that throughout the whole of the foregoing details we have in no case fixed the lead so as to hinder its freedom to expand. Where nailed, the nailing is on one edge of the sheet, or on "two contiguous edges"; not on "opposite" ones. Also, where the sheets may be dressed into position and secured without nails, this has been done. In all leadwork these principles should be adhered to.

513. Weight. In describing sheet lead its weight per foot super is referred to, not its measured thickness; the sheets are uniformly rolled and the weight is therefore proportional to the thickness. Its weight per cu. ft. is about 710 lbs., therefore a sq. ft. 1″ thick would weigh $\frac{710}{12} = 59\frac{1}{6}$ lbs. Suppose a sheet 1 ft. sq. to weigh 1 lb. its thickness is thus $\frac{1}{59}$″ or ·017″, and 5 lbs. lead would be $\frac{5}{59}$″, say $\frac{1}{12}$″ or ·083″ thick.

Open Slating

514. Where slates of moderate size are employed it is possible to economise in material, and incidentally to provide for roof ventilation, by leaving the slates apart at their sloping edges as shown in detail No. 195, which illustrates a portion of the slating to the shed of the workshop.

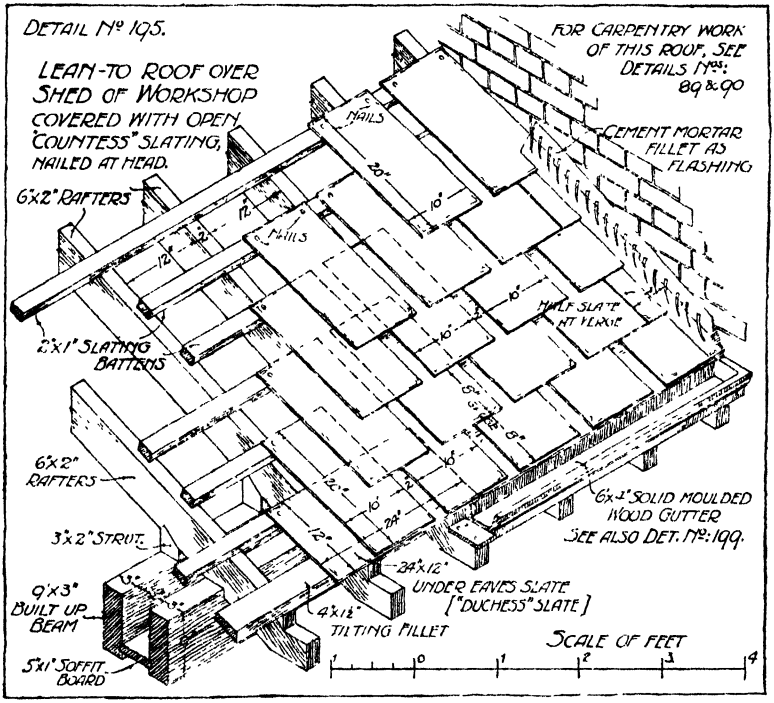
Countess slates are the smallest size for convenient application in a covering of any importance and these would allow of a space $1\frac{1}{2}$″ to 2″ wide between adjacent slates throughout the covering, while maintaining a side lap of 4″ to $4\frac{1}{4}$″ to protect the joint immediately below. Our example shows Countess slates nailed near the head, laid to 8″ gauge and 2″ apart on 2″ × 1″ battens, and it will be noticed that the bond is closed at the verge by the use of a half-slate (20″ × 5″) and that a 24″ × 12″ slate, known as a "Duchess" slate, is used at the eaves, to ensure perfect cover.

This type of slating is commonly applied to sheds, rough stores and temporary work where a ceiling is not required and also for iron

foundries and similar buildings where a free escape for fumes and foul air is desired.

Unless the slope of the roof is more than the average minimum for the kind and size of material employed (see table at page 130), snow easily drifts through to the interior.

Previous details have shown the application of a lead flashing at the verge, or junction of the roof with a brick wall, but this illustration employs a cheaper method, which consists of placing a



large triangular fillet of cement mortar (1 to 1) trowelled into the angle formed with the brickwork.

Such work requires to be carefully done with a cement which is not too fresh, and as little water should be employed as may be necessary to render the material sufficiently plastic for use. It is customary to ornament this fillet with curved V cuts or depressions, which serve to compress the mortar and localise any cracks tending to develop when contracting.

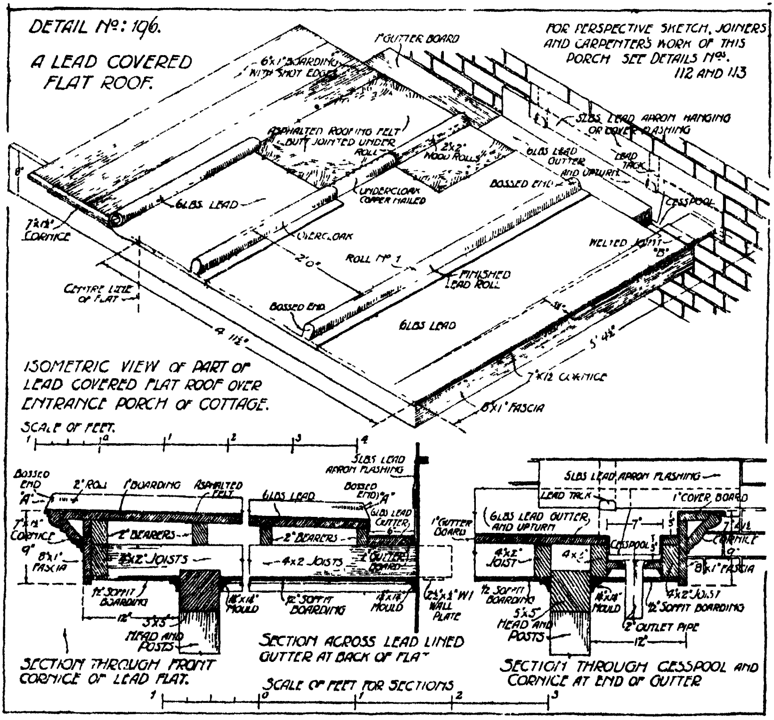
All surfaces of contact should be well wetted before laying the cement mortar, as this prevents rapid absorption of moisture from the mortar, with consequent shrinkage and lack of cohesion.

CHAPTER SEVENTEEN

ROOF COVERINGS AND FINISHINGS

Plumber's Work in Lead Flat to Entrance Porch of Cottage

515. The cottage porch is covered by a flat roof, the construction of which has been previously studied; the woodwork was specially prepared for lead covering.

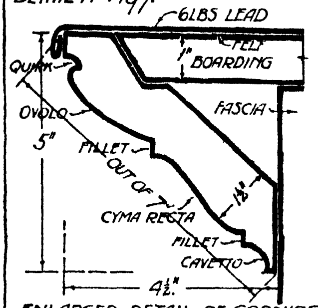


A level cornice surrounds the framing and the "flat" is allowed to fall from the cornice level at the front edge to a depth of 1¼" at the back, where a shallow gutter 6" wide collects the drainage and discharges it into a cesspool and outlet at the right-hand end.—See detail No. 196.

516. Solid rolls. The side cornices are weathered to fall inwards. The mode of covering adopted for a "flat" of small dimensions is to divide the width, at right angles to the desired "flow" of water, into strips 2 ft. or less in breadth, and joint the pieces of sheet lead at these positions by dressing them over 2″ × 2″ wooden rolls or by forming hollow rolls.

The former method is applied here. Our covering is of 6 lbs. lead, double turned over the edge of the moulded cornice.—See detail No. 197, which also shows an enlarged detail of the cornice mould. One sheet extends from the cornice to roll No. 1, and passes over the roll by ⅔ of its circumference where it is close copper nailed, as in detail No. 191. The next sheet overlaps the roll completely, gripping it at its narrowed base, and continues 2″ along the flat with free edges for expansion. "Under cloak" and "over cloak" are the names given respectively to the lapped over edge of the under sheet and the lapped over portion of the outer one.

DETAIL No: 197.

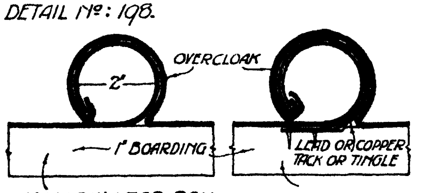


ENLARGED DETAIL OF CORNICE TO COTTAGE PORCH SHOWING FINISH OF LEAD COVERING
SCALE OF INCHES 1 0 1 2 3 4

These lead rolls have bevelled ends and rounded edges, to make them less prominent at the front and also to allow the surplus lead at the "roll lap" to be bossed satisfactorily to obtain close cover, with less abrupt change of direction.—See A, detail No. 196.

517. Hollow rolls. Hollow rolls are sometimes used, being similar in conception to a welt, but with much longer lap of the sheets, and turned into a hollow roll instead of being dressed flat upon the covering, as shown in detail No. 198. This is improved by inserting 2″ broad tacks of lead or copper at 2 ft. intervals along the roll, which makes them more rigid and better able to resist damage. Stopped ends to these rolls are often of defective shape and need great care and skill in finishing; where the end is exposed wooden rolls are preferable.

DETAIL No: 198.



HOLLOW LEAD ROLL WITH TACK OR TINGLE
SCALE OF INCHES 1 0 1 2 3 4

518. Gutter and cesspool. We have previously shown how gutters and cesspools are lined in the details of the main roof to workshop, and need not therefore repeat the information here. Careful perusal

of the sections and detail sketches will make clear any variations in application.

Observe that a "welted joint" is employed at B, detail No. 196, where the cornice cover flashing at the cesspool edge meets the main lead sheet running lengthwise of the side cornice.

519. Boarding and felting. Boards upon which lead is to be laid must invariably have their grain running in the direction of the "current," in draining the surface. They need to be "accurate in thickness" with "shot edges," jointed truly, and in best work tongued boards should be employed, at least $\frac{7}{8}''$ finished thickness, laid on rigid bearers which will resist the lead dressing without troublesome vibration.

Boards having their annual rings nearly vertical (see rift sawn floor boards at detail No. 77, in the chapter on Floors) keep their form best, avoiding both shrinkage and warping to any extent. Whatever care be taken some defects may be expected to arise and inequalities of surface develop, especially at the joints. To minimise such defects sheets of asphalted felt (sarking felt) are laid over the boards of the flat, any joints being made under the rolls with butt edges—*not* lapped. The felt must be of good quality, uniform in thickness and dependably remaining so, or its purpose is defeated[1].

Eaves Gutters and Down Pipes

In the various drawings of cottage and workshop, eaves gutters (in some districts known as spouting), and down pipes for conveying rain water to the drains, have been indicated; we must now consider their forms, jointing and method of support.

520. Wooden eaves gutters. In some districts wooden eaves gutters are still in use: they are made (*a*) from solid pieces of sound northern pine (red deal) hollowed and moulded as in detail No. 199; (*b*) from smaller pieces, built up with tongued and grooved joints, and in best work "lead lined," as illustrated in detail No. 200.

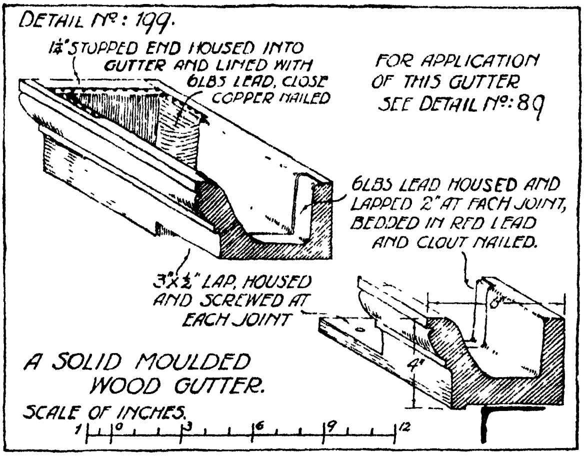
The first are cut from well seasoned stuff, free from all sap and defects, and coated two or three times on the back and interior with hot "carbolineum" or other wood preservative.

521. Joints. Should longitudinal joints be *necessary*, they are made by a "lap scarf" shown in detail No. 199, neatly prepared, well painted at least twice, then screwed firmly with "stout screws" through the freshly painted joint.

[1] See Manson's *Experimental Building Science*, Vol. I, for experiments on changes of form in timber sections.

Internally the joint is rendered watertight by housing a 4" wide strip of lead across the abutting ends, flush with the surface, bedded in red lead and oil, and clout nailed closely at the edges. At return moulded "stopped ends" a piece of the moulded front is obtained from a length of guttering, which is mitred and housed across the channel and lead lined.

If a square stop is required, the "housed stop" is similarly fixed but without the mould and its consequent mitre; see top sketch in detail No. 199. This type of gutter is applied at the eaves of the shed roof of workshop; detail No. 195.

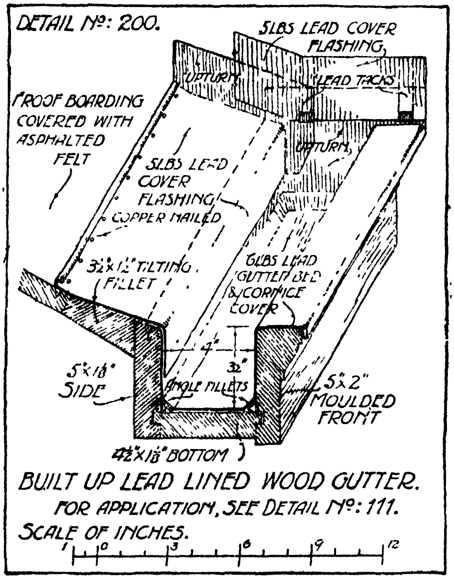


522. Built up gutters,—Main roof to works yard. Built up gutters are generally employed for cases where larger channels are required, and we have shown the application in the detail No. 111, as an alternative to the cast iron gutter, with the smallest probable dimensions of such a gutter. Its base is tongued to the back and front slabs and the channel lined with 5 or 6 lbs. lead similar to a parapet gutter, close nailed at one edge only and cover flashed. The detail No. 200 illustrates this clearly and shows the treatment of the lead flashings at the stopped end. Joints, where required, are similar to those in solid gutters.

523. Cast iron eaves gutters. Cast iron eaves gutters are the best of the cheaper gutters if kept in due preservation.

They are made in various forms, the most generally used being the "half round" section (for overhanging roofs) and "ogee" for supporting upon a corbel course or other level seating, where a moulded projecting edge is desired.

524. Sizes and jointing. Cast iron eaves gutters are manufactured in lengths making 6 ft. nett when erected; they vary in cross sectional dimensions from 4″ × 2½″ to 12″ × 6″, with a large number of intermediate sizes. Joints are usually formed by one end being enlarged to form a half-socket or "faucet" into which the plain sectional or "spigot" end of a similar section will lie and having sufficient play to bed the 2″ overlap in "red lead." The lap is held in place by a ⅜″ (to 1¼″) × ¼″ gutter bolt and nut having a countersunk head and by means of which a final grip of the packed joint is obtained, as detailed at A, No. 201.



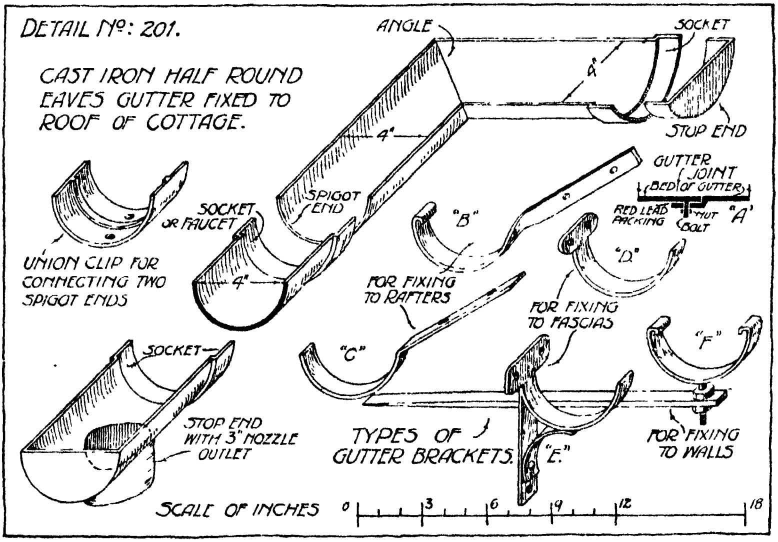
525. Special parts. Detail No. 201 also shows the specially cast parts provided for square stopped ends, and mitred return angles both internal and external where the gutter is to be carried round the angle of a building.

526. Outlets. Outlet "nozzles" or "drops," 5″ long, are usually cast upon the lengths of gutter to suit the required position of the down pipe, as, for example, in the left bottom corner of detail No. 201, the drop being similar to the pipe in size and discharging into top section of the down pipe. In heavy gutters with large outlets it is difficult to cast the outlet pipe satisfactorily upon the gutter, in which case the gutter is prepared with an outlet hole, having a thickened rim, drilled and screwed to receive ⅜″ "set bolts." A

separate outlet "nozzle" is then prepared with a machined top rim and overhanging flange which is packed and bolted in position.

527. Short lengths. When short lengths are required to make up a range of guttering, they may be cut from faulty pieces of standard length if the defects can be removed. These are also supplied by makers, having been obtained from the sound parts of otherwise defective castings.

528. Accidental joints. Should a sound gutter be fractured at the socket end when erecting, it may be cut square, and a "clip" used to connect the two "spigot" ends. One form of clip is shown



at detail No. 201 to be used for half round gutters, being prepared as a junction piece with a central band to ensure the equal entry of the two pieces.

529. Supports for gutters. Gutter supports and stays should be of wrought iron made to suit the woodwork of the roof in which they are employed.

When the "whole support" is provided by iron fittings, the outer end is shaped to the exterior form of the gutter and the other bent to be fixed to the woodwork in convenient positions.

Detail No. 201 includes illustrations of several types of gutter bracket for supporting the half round eaves gutters which we have applied in our examples. Considering these in order as lettered:

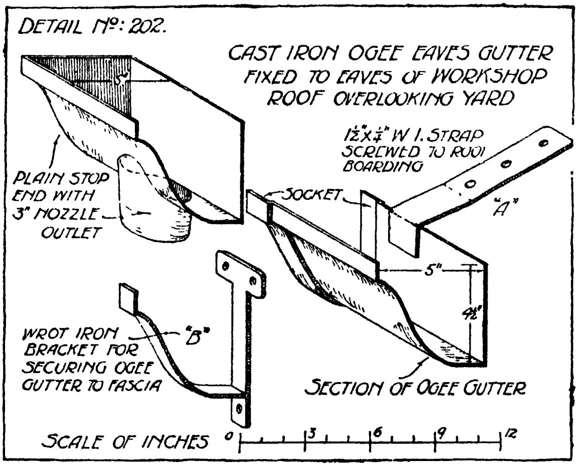
"B" is designed to be fixed by screws to the vertical face of the rafter, hence the "twist." Notice the "clip end" to receive the front top edge of the gutter and prevent movement.

"C" is the common form, prepared to lie on the top of the rafter and shaped accordingly. It is fixed by screws through the top face.

"D" is a form suitable for screwing to a vertical fascia; somewhat weak and must be used for light gutters or be more closely spaced.

"E" is also prepared to screw to a fascia, and is a better, stronger and more ornamental form.

All the above forms of bracket should be adjusted to give the necessary falls when fixing in position.)



"F" consists of a bar to drive into the horizontal joints of the wall with a supporting cup bracket having a "screwed standard" and "lock nuts" for adjusting the height to falls. This becomes necessary because the position of the "bar" is governed by the horizontal joints of the walling.

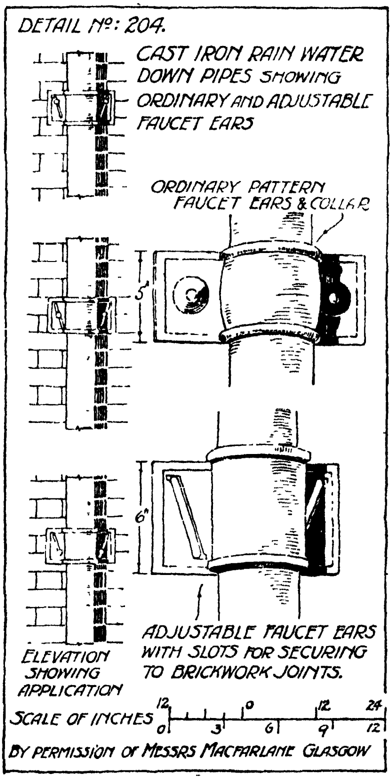
Detail No. 202 illustrates a 5″ × 4½″ ogee gutter for application to the eaves of workshop roof overlooking yard, as previously indicated in detail No. 104, with a plain stop end and 3″ nozzle outlet.

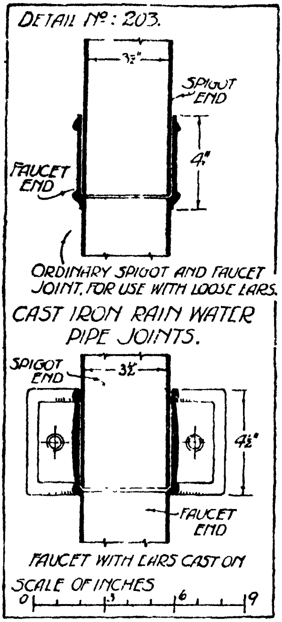
When ogee gutters rest on continuous corbel courses as in this case, they merely need holding in place. "Gutter straps" as at A, clout nailed (or screwed) to rafters or boarding, serve this purpose. The gutter may be removed for repairs by forcibly tilting, if not too tightly gripped when fixed.

If required to be supported on an overhanging fascia a wrought iron bracket of the form shown in the same detail, at B, may be used and screwed to the fascia.

530. Rain water or down pipes are vertical pipes, generally of cast iron, for the conveyance of rain water from eaves gutters to drains, having an internal diameter of 2″ to 4″ and made either round or rectangular in cross section. These are also known as "stack pipes" and "fall pipes."

Like gutters they are prepared in lengths which make a nett length of six feet after jointing, and are connected by spigot and faucet





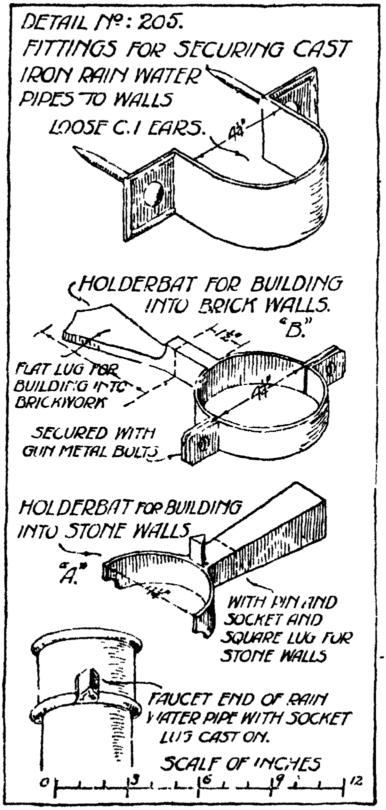
joints as shown in section at detail No. 203 and in perspective at detail No. 204.

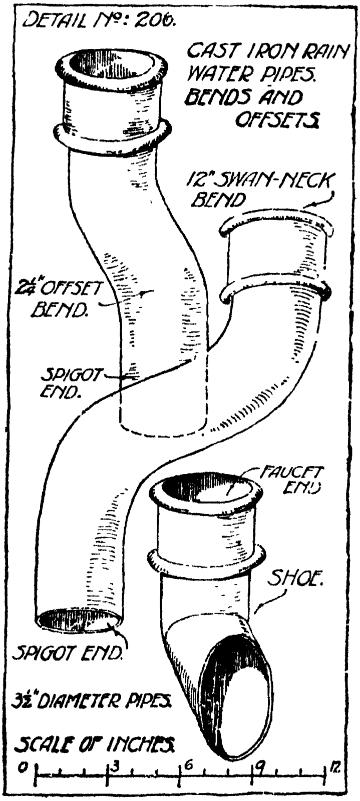
The average diameter in use for dwelling houses is 3″. Support is given to the sections by one of several methods. The cheapest is to have "ears," cast on the socket of the pipe, spreading flat against the wall for a length of 3″ on each side, which are nailed to plugs driven into specially drilled round holes 2½″ deep.

Detail No. 204 illustrates a method of overcoming the difficulty of fixing the ears to the wall, where, in the ordinary arrangement,

the holes would possibly not coincide with a brick joint. The improvement consists of slotted ears, sufficiently long to ensure that a joint must be enclosed within it. The slots are bevelled inwards and downwards, so that when fixed the pipe cannot fall vertically.

In order to allow of the backs of pipes being painted subsequently, the pipes are packed from the wall, by inserting 2" thick hardwood





"washers" or "bobbins" between the "ears" and the wall face, and using $4\frac{1}{2}''$ nails specially made for the purpose called "spout nails."

Other methods are available for either "close" or "clear" fixing, some of which are illustrated at details Nos. 204 and 205.

531. Loose ears. These are sometimes necessary for clasping pipes with plain faucet ends, one form being shown at the top of detail No. 205. It is a perfectly plain example, though these fittings are capable of decorative treatment.

532. Holderbats are employed for supporting pipes clear of the wall. A holderbat is a metal support which is built into the wall, having a dovetail lug for enclosing within a joint, or prepared for housing in and running with lead, similar to a hinge gudgeon. The former type is best suited to brickwork and the latter to stonework of good quality. Detail No. 205 at A is a holderbat prepared for stone walls, having a triangular stud projecting vertically from the bracket arm; the faucet end of the down pipe has a corresponding socket which fits the stud and prevents side movement in addition to giving support.

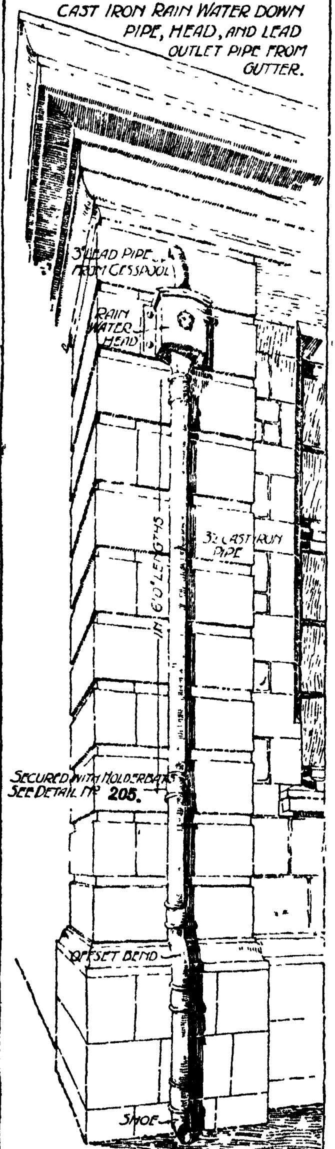
The holderbat shown at B, detail No. 205, is made to build into brickwork, and has a half loop recess to receive the pipe and a corresponding clip to complete the enclosure. Gun metal bolts secure the two sections which grasp the pipe firmly.

533. Bends and offsets. When a down pipe is required to convey water from an overhanging eaves a bent pipe is required to transmit it to the stack of straight pipe. This pipe is called a "swan neck bend." Its dimensions are specified by the horizontal distance between its vertical centre lines at the head and foot of the bend and by the diameter of the pipe; details Nos. 206 and 207.

When the pipe is required to clear a projection in the walling, *e.g.* a plinth course, an "offset" bend is used, which is similar to a "swan neck" bend but of small projection. This is shown on the same detail.

534. Shoe. A termination to a down pipe, where the latter discharges at the ground level, is illus-

DETAIL No. 207.
PERSPECTIVE SKETCH SHOWING CAST IRON RAIN WATER DOWN PIPE, HEAD, AND LEAD OUTLET PIPE FROM GUTTER.



THE CAST IRONWORK BY PERMISSION OF MESSRS MACFARLANE & Co GLASGOW.

trated at the foot of detail No. 207 and to a larger scale at No. 206. This fitting is known as a shoe and has a splayed foot which is placed at an angle to the wall and guides the discharge in the direction of an earthenware channel placed to receive it and leading to the drain.

535. Rain water head. To receive the outlet pipes from the cesspools, where these pipes come through the side wall of the workshop, cast iron rain water heads are provided below the stone cornice, forming a crowning feature to the stack of pipes, which would otherwise appear unfinished. A simple example is shown in detail No. 207, which gives an idea of the possibilities of artistic treatment of the rain water head.

536. Joints. Down pipe joints are commonly caulked with tow and made tight with red lead. In some cases they are packed with tow and run with molten lead. The section of the joint and the strengthening and ornamentation of the socket should be noted from detail No. 203.

537. Painting. All cast iron gutters and down pipes should be painted immediately they are cast and cooled. Gutters are covered inside and out with three coats of oil paint, the first at least being red lead paint. Down pipes are treated similarly on the exterior. To preserve the pipe, it is sometimes dipped while warm into a hot solution of tar and oil compound, and allowed to drip and cool.

It is almost impossible to paint satisfactorily after such treatment, hence in important work external painting has to suffice. In order to prevent premature destruction by continual oxidation of the metal, strong heavy pipes only should be specified and accepted for use.

538. Other forms of down pipes. It should be noted that down pipes are often made of lead or zinc, the details and application of which will be treated in a later volume.

MATERIALS, PLASTERER'S WORK, PAINTING AND GLAZING ARE TREATED IN VOLUME II.

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